MECHANICAL ENGINEERING

· NOVEMBER 1948 ·

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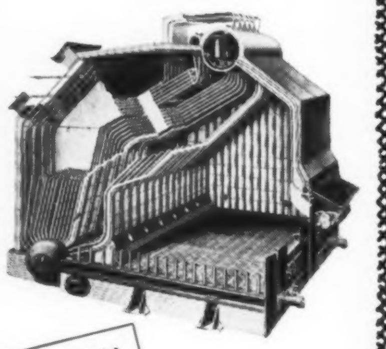

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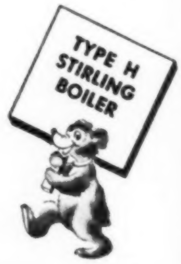

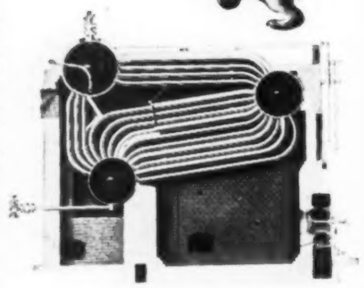

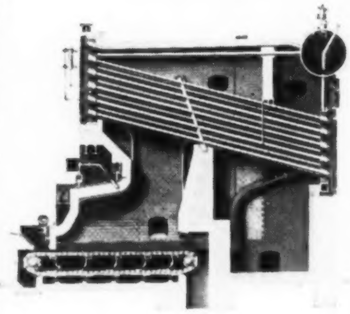

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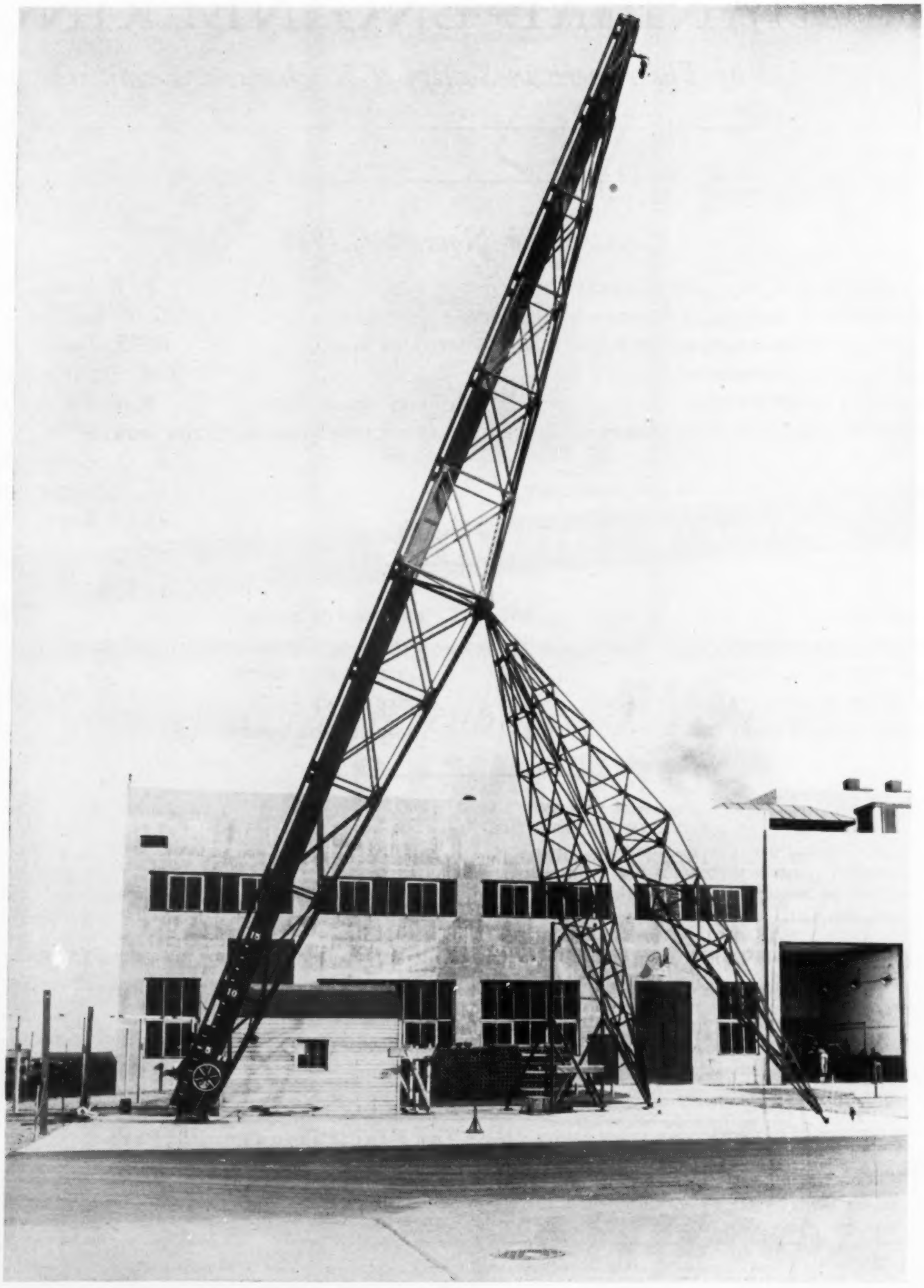

105-Ft Tower for Testing Ejection Seats for Airplanes at Naval Air Material Center, Philadelphia, Pa.

(*See article on page 883 of this issue.*)

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MECHANICAL ENGINEERING

NOVEMBER
1948

GEORGE A. STETSON, *Editor*

Engineering Man Power

THE supply of and demand for engineering man power are subjects of national importance and broad interest. Young men contemplating an engineering career and their parents are entitled to know what the opportunities are and whether or not the profession is becoming overcrowded. The secondary schools and all persons engaged in guidance activities need to be kept up to date. The colleges have a very direct interest because they must plan their programs and facilities to meet the demands likely to be laid upon them. Industry, which absorbs a major proportion of engineering graduates, has a very real stake. And it goes without saying that engineering societies, their joint organizations, and responsible members of the engineering profession are vitally concerned as to how man-power trends are likely to affect recruitment and economic status. Any report, therefore, that deals with man power commands the attention of engineers. Such a report, brief and nonstatistical though it be, appears in the September issue of the *Journal of Engineering Education*, official organ of the American Society for Engineering Education. It was prepared by the Man Power Committee of ASEE and presented at the 1948 annual meeting of that society last June.

In the current report the committee confesses that it was unable to arrive at numerical conclusions because of a number of uncertainties which it lists under three headings as follows:

A Some factors tending to increase demands or decrease supply:

1 Broadening base of types of employment.
2 Increased use of the engineering graduate in government services.
3 Possible mobilization.
4 Attrition due to inflation, tuition costs, and lack of government financial help.
5 Decreasing birth rate of 1930–1936.
6 Recognition by industry of demand for research in new product development, and increased efficiency (due to labor rates).

B Some factors tending to increase supply:

1 War-born interests in engineering and the large influx of veterans whose education was postponed during the war period.
2 GI benefits for majority of those who will graduate by 1950.

C Some factors tending to decrease demand:

1 Greater use of technical-institute graduates in subengineering positions.
2 Any possible severe business recession.

Of the questionnaires sent to 4247 companies, usable replies were received from 605 firms, later supplemented by an additional 300, a total of 905 companies. Engineering schools and government agencies at all levels were also interrogated. Attempts were made to match up the figures of the industrial questionnaire with statistics of the Department of Labor by classification of companies as made by the Engineers Joint Council, but discrepancies were such that the committee did not feel justified in submitting statistical data. In the opinion of the committee, present trends in engineering enrollment will result in a reasonable balance between supply and demand after 1951.

The committee notes that "it is possible that little or no surplus will be noticeable as engineering education has long been recognized as having great value as general education and as a good foundation for work in almost any profession." Because engineering education is "a rigorous discipline in careful, accurate, thorough work" and "inculcation of the scientific method of thought," "engineers have turned to many other professions with great success," the committee observes. "The need has long been appreciated," it continues, "for men who can intelligently use scientific method in dealing with problems of human relations, as well as with problems of utilizing the materials and forces of nature." It feels that "the encouragement of good men to continue advanced study is justified on the basis of developments and the desire for scientific careers of greater usefulness and achievement."

The committee sounds a note of warning based on its impression that the number of students anticipating careers in sales and administration is larger than normal. It contends that such objectives may lead students to choose nonengineering occupations and points out that "administrative responsibilities in industry and engineering are generally achieved through sequential and successful technical employment." This situation "calls for increased emphasis on the program of selection and guidance of engineering-college students, so that they may understand the requirements of the profession, the employment opportunities in it, and the possibilities of utilizing an engineering education as general education."

The committee summarizes its findings in the following words:

(*a*) That its earlier concept of the probable demand for graduate engineers was too small....

(*b*) That later enrollment statistics indicate a somewhat smaller supply of engineers....

(*c*) And that the long-range relationship between supply and demand over a period of several years of the future does not at present indicate a substantial excess of supply over demand....

Although the report of the ASEE Committee on Man Power is brief and fairly general, rather than statistical, in its statements, it touches on many points of great interest.

There is, for example, the question as to whether or not engineering education is as adequate a substitute for what has been called a general education as some persons have asserted. Some aspects of this question are discussed in an article by Harry S. Rogers which will be found elsewhere in this issue. It will be noted that the subtitle of Dr. Rogers' article emphasizes gaps between the statement and achievements of objectives in the education of the engineer. In the changes that have been taking place in engineering education over the past generation which look toward a greater emphasis on the socioeconomic stem of studies, and in the situation in which general education finds itself today, there is always to be noted this important gap. What we have set up as our objectives, and what we think our educational objectives are, suffer in comparison with a realistic assessment of achievements. Engineers have given lip service to the objective of broader curricula. They frequently maintain that an engineering education is an adequate substitute for a general education. They have devised many methods by which the best elements of engineering education and of general education can be combined in their curricula. But the gap between objective and achievement is still a broad one. Toward the closing of this gap the colleges, aided and encouraged by industry and the engineering societies, must put forth heroic and sincere effort.

If this gap can be closed, then engineers can assert with confidence and conviction that engineering education is a superior preparation not only for engineering pursuits but for more general ones. Even under present conditions an engineering education is useful in many enterprises and for careers that are not fundamentally engineering in nature. Engineering colleges should make greater efforts than they do today to encourage their graduates, those who are temperamentally so constituted, to enter careers in businesses not primarily based on engineering or demanding engineering skills. The temptation which graduates face of entering engineering enterprises is great and understandable, but other fields need their services too, even if they are not conscious of it, and the benefits to the nation will be great. Should this extensive field of service be cultivated, there will be little question in the future that the supply of engineers will outstrip the demand.

Another field of growing interest and opportunity for engineering graduates is government service. Except in civil engineering, the majority of engineers are privately employed. However, technology makes demands on government agencies that can best be met by men with an engineering training and habit of mind. Even the staunchest advocate of free enterprise must recognize the fact that the functions performed by government agencies more and more involve the services of engineers in local, state, and federal areas. These areas will afford an increasing number of opportunities which should further increase the demand for engineering graduates.

Nor should foreign service be overlooked as a field in which engineers may find profitable and satisfying careers. There has never been the urge or the necessity of training men for foreign service in this country that has existed, for example, in England. Lack of colonies overseas and a lesser dependence on foreign commerce by this country have contributed to the neglect which such careers have suffered. But our changed relationships with the rest of the world and the rapidly decreasing significance of distance open up new areas for the engineer. Some universities are giving attention to the education of young people for foreign service but emphasis is generally on politics and diplomatic or consular services of a nonengineering nature. Obviously, a young man attracted to foreign service, whether as a representative of a business enterprise or the government, should have some opportunity at college of preparing himself to meet some of the problems that such service will put before him and that are not common to problems encountered at home. Possibly some engineering schools have made provision for aiding the young men who expect to practice their profession in foreign lands. Even though the number of such young men may be small, the opportunity exists for some institutions to enter this field.

When greater attention is given by the engineering schools to the education of engineers for nontraditional areas of service, such as those mentioned in the foregoing paragraphs, the need will be more apparent than it is today for providing some means by which the engineering student can be intelligently and objectively informed on the essential characteristics of the fields of service that he may expect to enter and the functions in those fields that he may expect to perform. Some men are better suited by temperament to work at routine tasks, others demand variety and change. A boy should have some notion of the economic pattern of the industry he plans to enter. Is it reasonably stable or do its fortunes fluctuate rapidly from almost nothing to heavy overloads? Is he happier when he works alone or with many other men who have his abilities and background? Will he be better off in a small industry or a large one? In a public or a private enterprise? At home, or abroad? To separate glamor from fact, to look at the long pull instead of the immediate chance, to match personal talents and capacities with those demanded by the service he plans to enter requires selection and guidance of a quality now available to the student when he makes his choice of curricula on entering college. And not the least of the characteristics on which the graduate needs information is the demand for his services—one of the tasks that groups such as the ASEE Committee on Man Power, with the aid of industry, government agencies, and engineering societies, has undertaken.

POWDERED-METAL FRICTION MATERIAL[1]

By FRANCIS J. LOWEY

ASSISTANT CHIEF ENGINEER, S. K. WELLMAN COMPANY, CLEVELAND, OHIO

DESCRIPTION OF PRODUCT AND ITS FABRICATION

POWDERED-metal friction material is composed of a sintered mixture of powdered metals and nonmetals developed to achieve desirable friction characteristics. The most commonly used metal powders are copper, iron, lead, and tin. The most commonly used nonmetal powders are graphite and silica, although others are used to obtain special results. Generally, the powdered-metal friction material is classified as either a copper or iron-base mix, depending on which of the two is the predominant constituent.

Practically all powdered-metal friction materials are of bimetallic nature, because the sintered mixture, designed for frictional characteristics, is weak in tension and shear. Therefore, the sintered powdered material is supported by a core or backing plate, which is bonded directly to the sintered powdered metal, and which takes most of the mechanical stress required of the friction element. This core or backing member is usually low-carbon steel, but can be other material such as bronze, copper, or cast iron, all of which lend themselves to the fabrication techniques subsequently described.

Mixing of Powders. The dry powders of the constituent elements are sifted through various-size screens from 80 to 325 mesh, blended in the correct proportion, and thoroughly mixed to the desired point of homogeneity in standard mixers, using a rotating-type agitator. The mixed powders are then stored in sealed containers to prevent oxidation until they are molded into compacts.

Molding of Powders. All molding of metal powders for friction purposes is done in flat sections only. This is necessary to achieve a constant density, which has a very definite effect on the frictional characteristics of the sintered powdered metal. The molds can be of various shapes with relation to the contour, but they must maintain a parallel, vertical, cross-section cavity. The powders are molded cold at from 22,000 to 30,000 psi pressure.

Two fundamental types of molding are in general use. One is automatic molding, used on larger production quantities, whereby the mold cavity is filled volumetrically by automatic strike-off of excess powder. It molds one compact at a time, ejected automatically between cavity fills. The molds are usually proportioned to form a compact "to size," which eliminates many mechanical finishing operations on the friction element.

The other type molding process is known as hand molding, and involves the use of a powder charge determined by weight. The mold operator is responsible for spreading the powder evenly about the mold. In this process, Fig. 1, many compacts are spread on top of one another, and separated by steel spacers before the mold is put in a molding press for compacting. The same pressures are used in this type molding as in automatic molding.

[1] This article comprises Section 2c of Part II of the forthcoming ASME Metals Engineering Handbook.

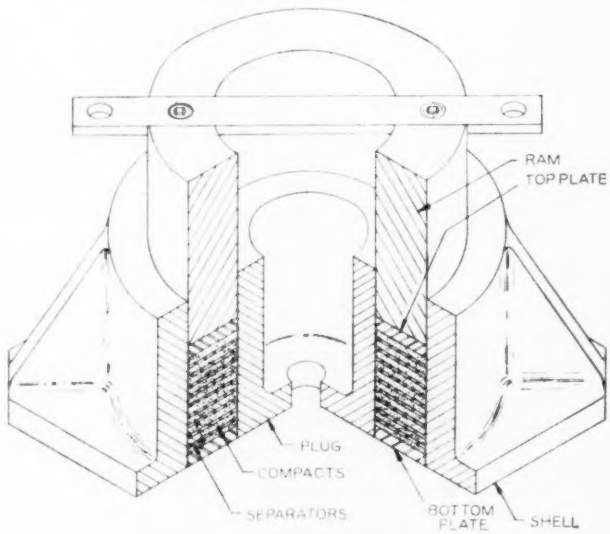

FIG. 1 HAND MOLD

Core or Backing Processing. Core or backing material is usually sheet metal of some standard gage, either cold or hot-rolled. Hot-rolled material must be pickled, oiled, and cleaned to give the scale-free surface necessary for bonding to the powdered metal. The sheet metal is prepared to shape by the usual methods, such as blanking, shearing, nibbling, or piercing. However, machine work is sometimes required, particularly where lugs or splines are necessary on small-quantity jobs which do not warrant the cost of a blanking die. Cast-iron, cast-steel, or plate-steel cores are used often, particularly on heavier-type applications. With these heavier cores, it is necessary to machine the surfaces on which the powdered-metal friction material is to be applied to a parallel flat condition and also to clean the surfaces entirely of defects such as scale and blowholes. A medium machine finish is all that is required. Hub sections or axial projections, Fig. 2, beyond the surface to which the friction material is bonded are difficult to accommodate in the sintering operation, particularly if they project beyond the friction thickness.

The cores or backings, regardless of material, are chemically cleaned and given a protective film of copper or nickel electroplating. This is a thin plate, about 0.0001 in. thick. The coating is necessary to prevent surface oxidation at the bond line during the sintering operation.

An important factor which must be considered in the preparation of the core is allowance for furnace growth and distortion during the sintering process. This growth can be predicted within certain limits. In most cases the cores are made undersize to allow for this expansion, but, where extremely close-fitting splines are required, it is necessary to machine the spline in the core after the sintering operation. Invariably, this is

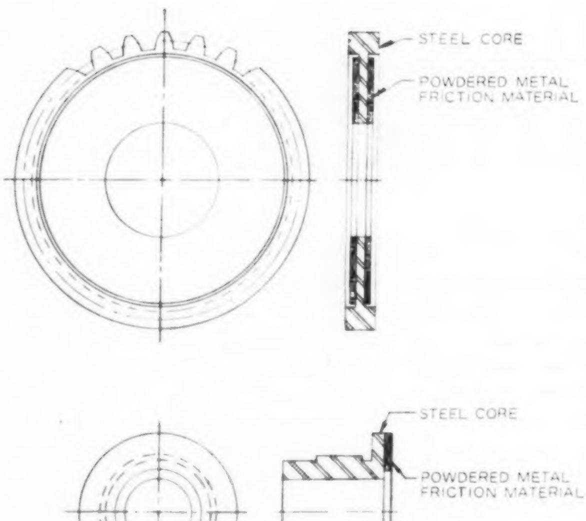

FIG. 2 FLANGE-TYPE STEEL CORES

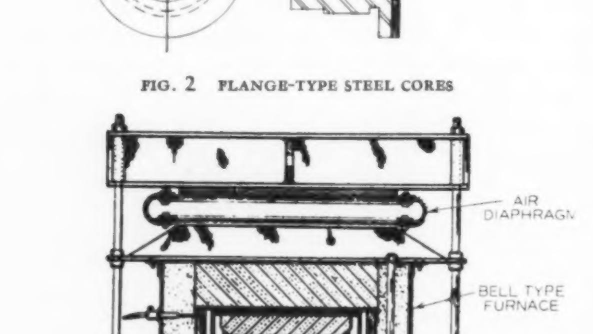

FIG. 3 CROSS-SECTIONAL VIEW OF SINTERING FURNACE SHOWING ARRANGEMENT OF STACKED DISKS WITH BELL-TYPE HEATING UNIT IN PLACE TO APPLY DOWNWARD PRESSURE TO STACK WHILE HEATING THE WORK

more expensive than machining the core before sintering and is not resorted to unless absolutely necessary. The flatter, more parallel, and stress-free the cores are previous to sintering, the more consistently and precisely the growth and distortion can be predicted. It is also important to remember that, in calculating the strength of the backing material, it must be considered in an annealed stage, since the sintering operation is carried on at a temperature of from 1250 to 1650 F with a very slow cooling cycle. Splines or lugs projecting beyond the friction material can be flame or induction-hardened after sintering, but precautions must be taken to avoid the heating of the friction material itself beyond the oxidation temperature of the particular mix involved. In most instances the friction element can be designed to obtain adequate spline strength without resorting to special hardening techniques.

Sintering and Bonding. Sintering refers to heat-treating powdered-metal compacts to convert them into a solid, coalesced metallic mass. Bonding refers specifically to welding or brazing the powdered-metal compacts to the steel cores. Both processes take place simultaneously in the heat-treating process. The cores and compacts are assembled in stacks in their required positions with adjacent assemblies separated by graphited stainless-steel separators which prevent them from sticking together. The stacks are then assembled on top of a furnace base, Fig. 3, to a required height, and a furnace can be put over the top of the stack, enclosing it tightly to maintain a reducing atmosphere. The can rests on the stack and is flexibly sealed on the bottom to accommodate a slight shrinkage of the stack which occurs during the sintering process. Next, a bell-type furnace is put over the can, rests upon it, and by means of an air diaphragm, applies a pressure of 100 to 200 psi on the friction surfaces. Pressure is maintained through the upward half of the heat cycle, the temperature varying with the particular material from 1250 to 1650 F. During the cooling cycle, the furnace generally is removed, but the furnace can is left in place until the stack is cool, maintaining the reducing atmosphere.

Finishing. The most common operations required in mechanically finishing the friction elements are grinding parallel and flat, trimming edges, deburring, forming to shape in the case of band or cone linings, drilling, counterboring, grooving, and notching. These operations are performed with the usual machine tools, with carbide cutting tools used in most instances.

It is necessary to mold and sinter the powdered-metal friction materials in flat sections. Therefore, all forming and bending to shape of bands or shoe linings, and male or female cone is done necessarily as a finishing operation after sintering. Since powdered-metal friction material is weak in tension, special machines are necessary to bend this product without overstressing the bands or lining, which would cause cracking and chipping of the sintered powdered material.

ADVANTAGES AND GENERAL OPERATING CHARACTERISTICS

Inclusions. Proper processing of sintered powdered metal affords an excellent control of the ingredients and their dispersement. This contributes to the excellent frictional characteristics of powdered-metal friction material. Many of the ingredients act individually on the friction surface and some act in alloy or in conjunction with other ingredients. For example, the base, or main metallic ingredient, contributes greatly to the frictional properties. It also forms the matrix, or metallic network, which holds the mass together and contributes most to the conduction of heat from the friction surface. Minor metallic ingredients either alloy with the main metal or other adjacent metals to produce a stronger or alloyed matrix, or act individually, contributing toward the resultant friction properties. The fine evenly dispersed inclusions of nonmetallics are very important. They add greatly to the favorable characteristics of powdered-metal friction material by contributing to the frictional properties through inhibiting galling, scoring, and seizure, increasing the wear resistance, and somewhat in preventing metal flow at very high temperatures and pressures.

Properties. The greatest single property which justifies the use of powdered-metal friction material economically is its great wear resistance.

Other outstanding properties of powdered-metal friction materials are as follows:

1 They can absorb energy at higher rates than most organic friction materials, and therefore can be used at higher temperatures and at greater pressures and speeds. This, at least in part, is due to the fact that the metals can stand higher surface temperatures than organic materials before melting or disintegrating. This is important to the designer because he can rely on more consistent friction properties through a greater range of operating conditions. For high-energy-absorption brakes and clutches, it means smaller, lighter, and more compact designs.

2 They can absorb a greater portion of the heat of the friction application than other types of friction materials. This is advantageous to the engineer for several reasons: (*a*) It means more wear resistance and better life for both the powdered-metal friction surface and the opposing surface, because the energy is dissipated in two directions more quickly from the contact surfaces. (*b*) It means less distortion, heat-checking, and scoring of the opposing surface, which is often a deciding factor. (*c*) It is desirable for inaccessible applications.

3 They have a more constant coefficient of friction through temperature and pressure variations than accompanies most other types of friction material. This is due to the greater stability of ingredients making up the product, and is particularly important in the design of slip clutches. The material is very reliable on applications such as tension-control clutches, overload clutches, reel-winding devices, and brakes which of necessity must slip for long periods of time.

4 They are not affected appreciably by climatic or other extraneous conditions, such as heat, cold, dampness, salt water, and fungi. Within a practical range, they are inert to chemical changes caused by heat, water, oil, solvents, fungi, and salt water. Fluids will lubricate the friction surfaces and cause a lower coefficient of friction. The friction material can be cleaned of foreign substances, and the original coefficient restored either by action of the clutch, wiping with a solvent, or refacing the material mechanically.

This property is important in numerous applications because it means more consistent results through many operating conditions. It is the practical friction material to use where occasional contact with fluids is possible, and where salt water, fungi, or dampness can affect the friction material. This property also is one of the important reasons why powdered-metal friction material is ideal for wet applications, as when the clutch or brake is immersed in a fluid. Often this is the same fluid that lubricates the gears and bearings of a power transmission. This stability is important also in designs which necessitate the use of clutches in inaccessible spots where a breakdown would mean extensive and costly repair.

5 They offer important design properties for both economic and functional advantages. Because of the greater wear resistance and greater physical strength of the bimetallic powdered-metal friction material, it is often possible to design a smaller, lighter, and more compact friction assembly. The steel backing member also can be used as a structural part of the brake or clutch mechanism, saving both weight and assembly costs.

Design Requirements. The coefficient of friction and other frictional properties can be altered to a wide degree by varying the constituents and the molding and sintering techniques. Standard materials are available for most applications. However, many mixes have been evolved for special purposes. Materials can be furnished to meet such requirements as specific static or dynamic coefficients of friction, high wear resistance, high energy absorption, and constant coefficient. Generally, materials are available with coefficients of friction varying from 0.05 to 0.5. This type of information must remain general because it is easily misconstrued and cannot be given accurately, except for one stated set of conditions. The frictional results depend on factors other than those of the friction material, such as opposing material, surface condition, over-all design, and heat-absorbing and dissipating characteristics of the clutch or brake. Data needed to determine accurately the proper friction material are as follows:

1 A brief description of the clutch or brake design.
2 Dimensional requirements.
3 The speed of engagement.
4 Opposing surface material and description.
5 Total or unit pressure on friction elements.
6 Power or torque requirements.
7 Desired life expectancy.
8 Operating conditions such as frequency of application, dry or lubricated surfaces, and type of lubrication.

Opposing materials used against the powdered-metal friction material can be those customarily used against ordinary friction material. The most popular of these is cast iron or carbon steel. In some instances, it is desirable to harden the opposing surface. This is particularly true of multiple-disk applications, where the energy absorption is extremely high or the strength and dimensional requirements are such that hardening and grinding operations are desirable. In a few cases of extremely high-energy-absorption applications, it has been found advantageous to chrome-plate the opposing surfaces. The condition of the opposing surface must be as smooth as it is practical to obtain. For an ordinary application a very smooth machine finish is satisfactory, but often a ground finish is preferable. In ordinary multiple-disk applications, the cold-rolled finish of sheet steel is adequate, but, in more precise applications, grinding may be necessary for a smoother and flatter opposing surface. The smoother and truer the friction contact surfaces, the shorter the break-in period and the better the frictional results.

APPLICATION AND INSTALLATION DATA

Single Face. Single-faced powdered-metal friction material is that which has friction material bonded to one side only of the backing member. This type of friction element is usually of the rivet-on type, whereby the friction material is attached to the carrier by rivets.

Standard rivet patterns are generally adequate with bimetallic friction material. Occasionally, however, existing rivet patterns have to be rearranged, or have additional rivets added to button down corners or increase the total riveting strength. Powdered-metal linings, when substituted for the same thickness of asbestos-type linings, are heavier and the contact of the riveted surfaces is generally metal to metal, which has a lower coefficient of friction than the friction surface. Powdered-metal linings, therefore, require more rivet shear strength. A rule of thumb that is safe to follow is to have at least one rivet for every 4 sq in. of rivet surface, with maximum space between the rivets of $3^1/_2$ in. and with the outer rivets not more than $^3/_4$ to 1 in. from the edge.

Because of the greater rivet strength required, it is recommended that only semitubular steel rivets be used and that they be set with a roll clinch, never with a star clinch. The roll clinch is considerably stronger and minimizes the possibility of small, loose pieces injuring the friction surface.

TABLE 1 STANDARD RIVET SIZES
(Included angle of head = 150 deg)

Rivet size	Body size, in.	Head size, in.	Minimum distance from edge, in.
D	$^1/_4$	$^1/_2$	$^5/_8$
C	$^3/_{16}$	$^3/_8$	$^1/_2$
B	$^3/_{16}$	$^5/_{16}$	$^3/_8$
L	$^5/_{32}$	$^5/_{16}$	$^3/_8$

The rivets, as recommended in Table 1, are designed to countersink entirely in the steel backing, Fig. 4, thereby making the entire thickness of the friction material available for wear. Screws of these same sizes are also available. However, screws are not recommended unless they are anchored in some manner to preclude the possibility of their working loose and damaging the friction surface.

The most common steel backing is mild carbon steel, SAE 1010 to 1035, 16 gage (0.0598 in.). This backing is adequate for material up to an over-all thickness of $^1/_4$ in. Over this thickness, 11 gage (0.1196 in.) is generally used. It will be noted that at least 16-gage steel thickness is required for the use of the rivet-counterboring technique mentioned.

Welding is also an excellent means of fastening single-faced

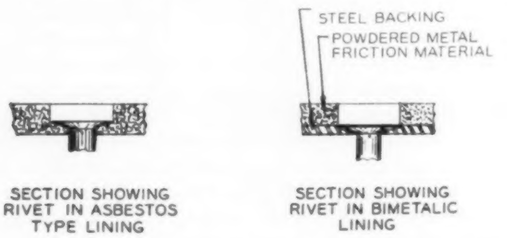

FIG. 4 LINING APPLICATIONS WITH COUNTERSUNK RIVETS

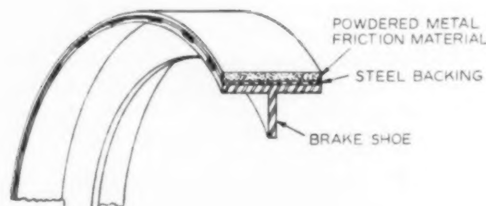

FIG. 5 TACK-WELDED BRAKE LINING

bimetallic friction material to carriers. Arc, spot, and projection, or stud-welding may be employed. Certain precautions must be observed because the friction material can be injured if it is overheated and oxidized or distorted. The welding heat must be distributed as much as possible. If the edges of the friction material, Fig. 5, are in line with the edges of the carrier, it is possible to tack the friction segment in place by means of arc-welding along the line of contact between the steel backing and the carrier, provided that the operator is cautious not to injure the friction material by overheating in more than very local spots. A considerable number of small welds is best in this case. Often, a friction element can be designed with the edge of the powdered-metal friction material located back from the edge of the steel backing about $^1/_8$ in., so that welding can be done along the edges of the steel backing and the carrier with minimum possibility of injuring the friction material. This type of tack-welding is readily chipped off and ground down for replacement of the lining.

It is possible to spot and projection-weld through the bimetallic friction material. In spot-welding, it is necessary to compromise on the weld to a point where a satisfactory weld is obtained and yet not enough localized heat and pressure have been applied to the friction material to cause it to dent and become harder and more dense, thereby creating the possibility of scoring the opposing surface. This situation can be avoided by having the electrode which comes in contact with the powdered-metal friction material of as large a cross section as possible. In projection-welding it is necessary to have the projection on the carrier, because it is not practical to develop projections on the steel backing through the sintered material. Also, because of the stacking of the parts in the process, the projections cannot be put in previous to sintering.

Ring Facings. Ring facings are one of the most popular types of single-face friction elements and are made in both the full-ring and segment-type forms. General dimensional tolerances which have proved adequate for this type of friction element are given in Table 2.

TABLE 2 DIMENSIONAL TOLERANCES OF RING FACINGS

OD and ID	±0.015 in.
Thickness up to $^1/_4$ in.	±0.003 in.
Thickness over $^1/_4$ in.	±0.005 in.
Parallel within	0.005 in.
Rivet spacing	±0.005 in.
Chordal spacing of slots or segment cutoff	±0.032 in.

On many full-ring facings it is necessary to slot the facing, Fig. 6, because of metallic thermal expansion of the metallic lining from absorption of operational heat. These slots are generally from the OD and are usually equally spaced with 4, 6, or 8 notches, particularly if the rivet pattern is symmetrical. A typical notch is one with a $^1/_{16}$-in. radius at the root, with a 5 deg included angle tapering out toward the ID. After sintering, this notch is usually blanked in the facing to a depth of about two thirds the width of the facing.

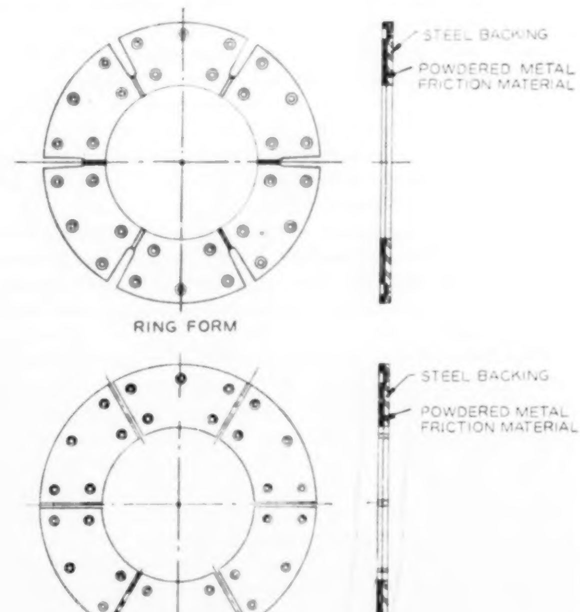

FIG. 6 RING FACINGS

In the segment-type facing the space between the segments usually takes the place of the notch in the full-ring facing. In large quantities the segment may be molded to size. However, in most cases, segment-type facing is made in full-ring form and segmented by means of a shear die as a finishing operation. The usual cutoff or space between segments is $^1/_8$ in.

Blocks—Cylindrical. This type of facing, Fig. 7, is a portion of a cylindrical surface and may be used either for external contracting or internal expanding parts, depending on whether it is

required to have the friction material on the inside or small radius, or on the outside of the block. Recommended dimensional tolerances are given in Table 3.

TABLE 3 DIMENSIONAL TOLERANCES OF CYLINDRICAL BLOCK FACINGS

Width of block	$\pm 1/_{64}$ in.
Length of block	$\pm 1/_{32}$ in.
Thickness to $1/_4$ in.	$\pm$0.003 in.
Over $1/_4$ in.	$\pm$0.005 in.
Hole location	$\pm$0.005 in.

This type of facing is molded or sintered flat, sometimes in multiple lengths. It is ground flat in this condition and then formed to radius. This type of block is brittle and generally cannot be bent or rebent except by the manufacturer, who has special equipment for the purpose. Therefore it is advisable to have the manufacturer bend these blocks to exact diameters. Because the blocks are rigid, it is better to have a greater quantity of small blocks for flexible-band application. In any case,

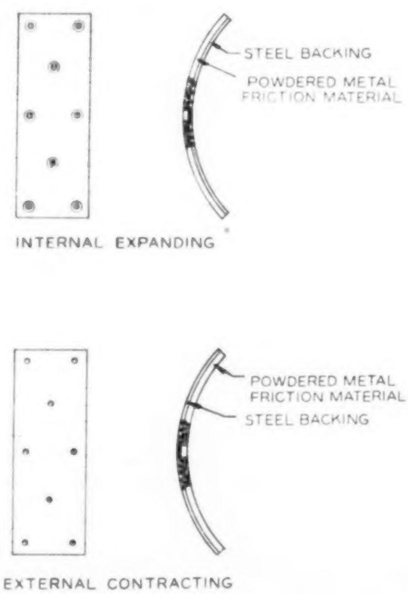

FIG. 7 CYLINDRICAL BLOCK LINING

even in solid shoe-type application, it is better not to have too large a block. The space between smaller blocks acts as a groove to scavenge any surface dirt, to remove oil and grease, and to allow for thermal expansion. Spacing between blocks should be at least $1/_8$ in.

For proper functioning of this type application, it is important that the friction element be given a good fit both to the carrier and to the drum against which it operates. To do this the manufacturer must have either the thickness of the block and the drum diameter, or the drum and shoe diameters. The shoes and bands must be in good shape, with accurate curvature, or they will distort the friction blocks at assembly, and much of the advantage in the use of powdered-metal friction will be lost. Bimetallic friction material has much greater wear resistance and is less resilient than other types of friction linings. For an excellent fit and optimum performance, it may be advisable to have the manufacturer make the blocks oversize in thickness, allowing for machining to a perfect fit after assembly.

Grooves, either lateral or criss cross on the block, are added for wet applications for quick removal of the oil from the friction surface, particularly if the block is long.

The maximum over-all thickness generally economical to manufacture is about $3/_8$ in., although, in special cases, blocks have been made to greater thickness. In applications where bimetallic lining is to replace other linings of great thickness, it is recommended that shims be used between the lining and the carrier. These shims can be of any material suitable to the particular application.

Blocks—Conical. This type lining, Fig. 8, is made with both male and female form, in which the friction material is on

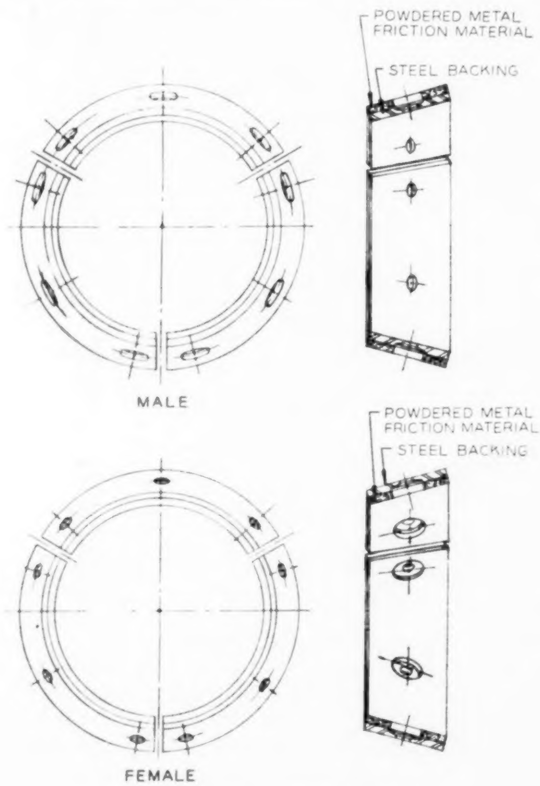

FIG. 8 CONICAL BLOCKS

either the outer or the inner surface of the cone. All specifications given for the cylindrical lining are also true for the conical lining. This type lining requires special bending equipment similar to that for cylindrical linings, and this equipment has the limitation of bending cones up to a 20-deg angle. It is also recommended that the angle of coverage of each segment shall not be over 120 deg, or at least 3 segments per cone lining.

Conical linings are generally used at higher pressures than most other types of friction linings. Therefore it is recommended that greater care be taken in the fastening of the lining to the carrier. In many cases, the lining is both riveted and tack-welded along the edge.

Blocks—Straight. This type of single-face lining is rectangular in shape and has the same specifications as the foregoing blocks. It is furnished with standard mixes for regular friction applications and often with special mixes for wear-plate applications, the main purpose of which is wear resistance when run against other materials.

DOUBLE FACE OR SANDWICH TYPE FACINGS

Carrier Bonded on Both Sides. This type of friction element is probably the most popular of the powdered-metal friction ma-

terials. The powdered-metal friction material is bonded to both sides of the steel core, forming a sandwich, with the steel core usually protruding beyond the powdered-metal friction material on either the ID or OD. A spline or provisions for a hub can be machined into this protruding steel for disk or plate-type application.

Disk—Spline Type. The disk-type application, Fig. 9, is popular, probably because it takes full advantage of the design possibilities of powdered-metal friction material. The disk can be made to a great variety of thicknesses and diameters, with any type of spline or lug for driving purposes. This allows the design engineer flexibility in adapting a clutch to specified size requirements.

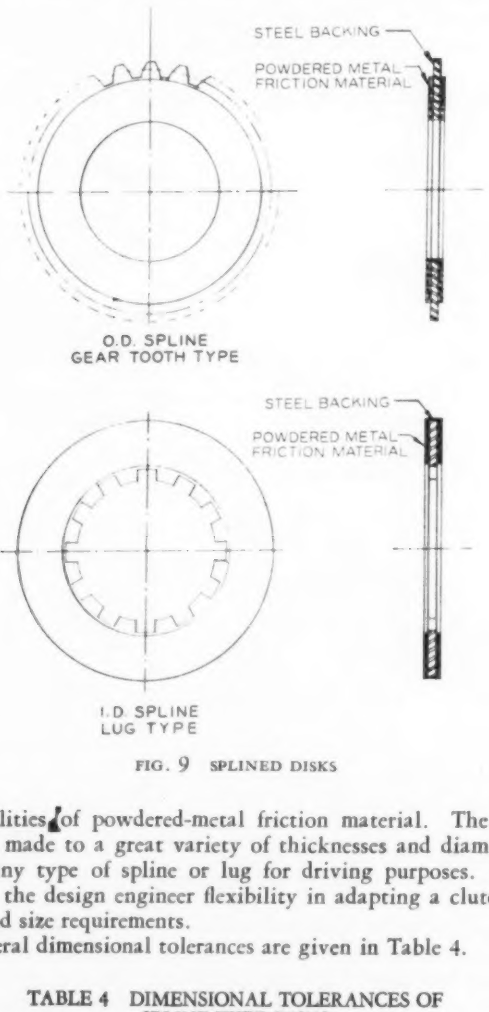

FIG. 9 SPLINED DISKS

General dimensional tolerances are given in Table 4.

TABLE 4 DIMENSIONAL TOLERANCES OF SPLINE-TYPE DISKS

Thickness up to $^1/_4$ in.	±0.003 in.		
Thickness over $^1/_4$ in.	±0.005 in.		
	Up to 5 in.	Up to 12 in.	Over 12 in.
Gear-teeth pitch diam.	±0.005 in.	±0.008 in.	±0.015 in.
Flatness within	0.007 in.	0.010 in.	0.015 in.
Parallel within	0.003 in.	0.004 in.	0.005 in.

The most popular spline for this type friction element is the standard, involute-gear tooth. In small quantities the gear teeth are hobbed or shaped on the steel core prior to sintering, with the allowance being made for expansion during the sintering heat-treatment. In large quantities it is recommended that gear blanking be considered, as it is more economical and assures greater consistency of gear-tooth spline backlash.

It is recommended that the friction-material diameter be maintained away from the root diameter of the spline. An allowance of 0.090 in. should be made between the friction edge and the spline root. This is to allow for compact variations and deviations in setup to assure that the friction compact never protrudes into the spline.

On large spline applications of over 12 in. diam it is difficult to predict accurately the expansion in the steel core during the sintering operation. When possible it is advisable in such cases to machine the spline after sintering, in order to reduce the specified tolerance of pitch diameter, as in the case of gear-teeth splines. With thin disks it is impractical to machine splines on sandwich-type disks after sintering, because the steel core overhangs the friction material and is unsupported during the machining operation. This situation is overcome either by blanking the spline after sintering, in which case the die is recessed to accommodate the friction material, or by using spacer washers of the proper diameters so that rings, when stacked for machining, are clamped or held by the protruding steel core rather than by the friction material. The spacer washers are necessarily machined and are expendable.

Many multiple-disk clutches run in oil baths, usually in the same oil as the gears and other mechanism. In such cases, it is good practice to oil-groove the disks. The most popular of these is a spiral groove in which the groove runs from OD to ID This type of groove is usually a sharp-edged, round-bottomed groove about 0.060 in. pitch, 0.020 in. wide, and with a maximum depth of about 0.030 in. It is recommended that on thin disks the grooving should not extend closer than to within 0.007 in. of the steel core.

Radial grooves can also be machined in the friction material and are often preferred functionally, although they are usually more costly because they cannot be machined as expeditiously. This type groove is usually equally spaced around the ring, the number of grooves varying from 2 upward, depending on the particular application. A standard groove is $^1/_8$ in. wide, formed to within 0.007 in. of the steel core, with sharp edges and a slight fillet on the bottom. Chordal spacing and alignment from side to side are generally within $^1/_{32}$ in.

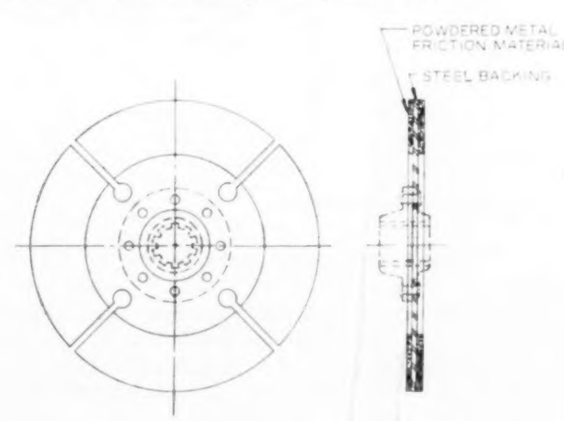

FIG. 10 DISKS—HUB TYPE

In some critical wet applications, where quick removal of the fluid is an absolute necessity, both types of grooves are necessary.

Disk—Hub Type. This type friction element, Fig. 10, usually has a steel core protruding on the ID to a small diameter, onto which is riveted a hub carrying a spline. It is used mostly on plate-type applications, such as automotive and industrial clutches, and has the same general dimensions as the spline-type disk. In most cases the diameters and rivet holes in the steel core are machined or blanked prior to sintering. However, in cases of close tolerances, they can be machined or blanked after sintering for a more accurate fit to the hub.

The advantages of bond-on plate over the customary rivet-on facing for this type of application are as follows:

1 It can be made thinner because thickness of material does not have to be allowed for the rivet head and the rivet clinch.
2 It has better heat conduction and dissipating characteristics.
3 It can withstand higher centrifugal force, because of the direct bond to the steel carrier plate.

It must be remembered, however, that the structural strength of the steel center plate, or core, must be computed under annealed conditions.

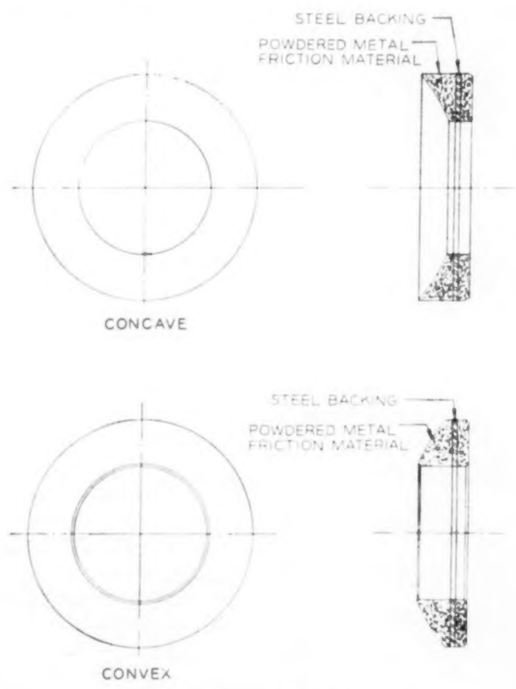

FIG. 11 DISK-TYPE SEALS

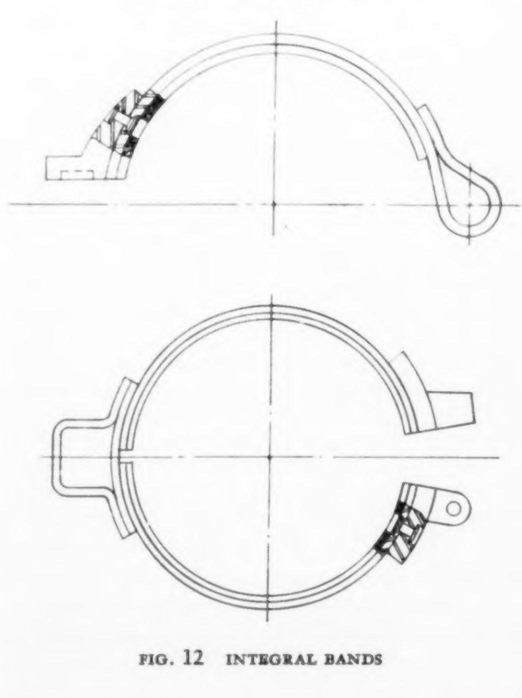

FIG. 12 INTEGRAL BANDS

Disk-Type Seals and Thrust Washers. Powdered-metal materials of this construction are highly satisfactory for seals and thrust bearings, Fig. 11, which are required to meet high thermal and mechanical shock-load conditions. No general dimensional data are given for these parts as they are machined to order for particular applications.

SPECIAL ASSEMBLIES

Integral Bands. In structural design, use is made of the steel backing of the bimetallic friction material, Fig. 12. The backing is used also as the brake band, with the anchor loops, clevises, and end brackets being fastened directly by riveting or welding. The flexibility of the band can be controlled by the thickness of the steel backing and by grooving the friction material at equal intervals to the steel backing. In calculating the band strength, consideration must be given to the annealed condition of the steel. Bands of this type have been made in many lengths up to two complete wraps or 720 deg. The advantages of this type application are as follows:

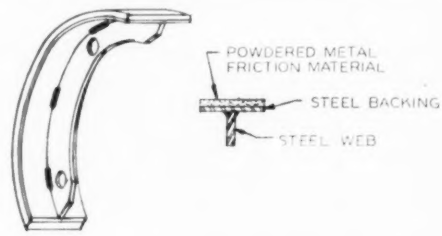

FIG. 13 INTEGRAL SHOE

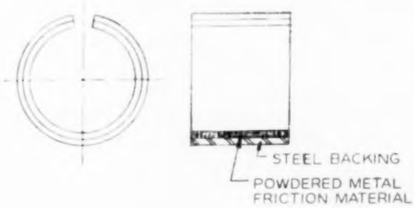

FIG. 14 STEEL-BACKED BUSHING

1 It makes a lighter, more compact unit.
2 It has better heat conduction and dissipating properties.
3 It saves the cost of making separate linings and bands and assembling them together.

Integral Shoes. This application, Fig. 13, is similar to that of integral bands, except that, in this case, webs can be welded to a curved piece of bimetallic lining, forming a rigid shoe. The webs can be blanked from sheet metal and will contain the anchor-pin holes. Often a complete shoe of this kind can be produced for little more than the cost of making the rivet-on type lining, thereby saving the expense of a separate shoe and assembly.

Steel-Backed Bushings. These bushings, Fig. 14, can be made for either friction or bearing applications. They are preferred over regular solid powder bearings in cases where special frictional properties are required, or where structural strength requirements necessitate the steel backing. These pieces are molded and sintered in flat sections and then surface-ground and bent to curvature. They are generally left open-ended, since it is impractical to weld the ends closed. Materials are available which can be used on the following types of steel-backed bushings: lubricated bearing applications, unlubricated bearing applications, and wet or dry-friction applications.

Evaluation of REYNOLDS NUMBER *by* GRAPHICAL METHODS

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MANY problems in fluid mechanics involving Reynolds number are solved graphically, making it unnecessary to know the exact value of Reynolds number to obtain a solution. The frequent use of Reynolds number in hydraulics, fluid mechanics, and aerodynamics makes it desirable to be able to obtain an approximate value for this quantity at a glance. Two expedient methods of determining Reynolds number graphically are shown herewith, each method presenting its own merits.

Reynolds number, a dimensionless quantity and denoted by N_R, is determined by computation from the formula

$$N_R = \frac{VD}{\nu}$$

in which V is the velocity of the fluid flowing, D the diameter of the pipe, and ν the kinematic viscosity of the fluid. For sections other than round, with turbulent flow, the hydraulic radius R, defined by

$$R = \frac{\text{Cross-sectional area}}{\text{Wetted perimeter}}$$

can be used, in which case

$$N_R = \frac{4RV}{\nu} \quad \text{or} \quad D = 4R$$

For specific values of V in feet per second, D in inches, and ν in square feet per second, the value of N_R can be determined as illustrated in Fig. 1. From the intersection of the rectangular axes representing the diameter of the pipe and the velocity of the fluid in the pipe, a line run at 45 deg to these axes to the corresponding kinematic viscosity will indicate the Reynolds

(*Continued on page 890*)

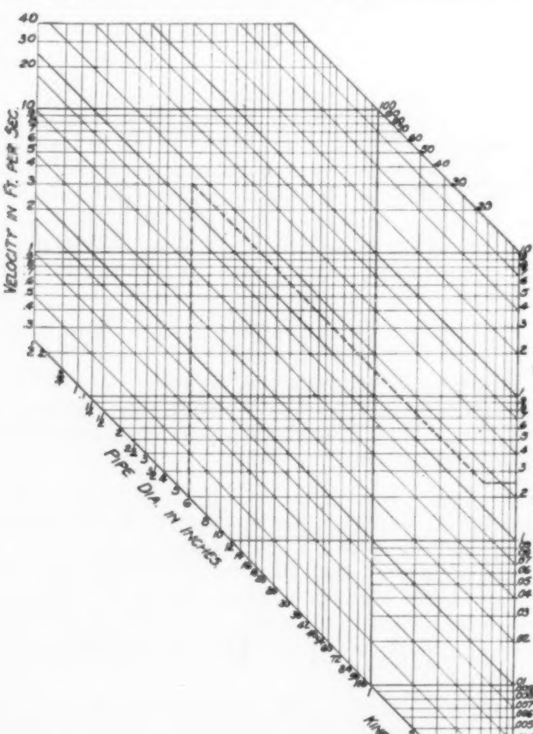

FIG. 1 CURVE FOR GRAPHICAL SOLUTION OF REYNOLDS NUMBER FROM THE EQUATION $N_R = VD/\nu$

(The dotted line indicates the Reynolds number for water flowing in a 6-in-diam pipe at 3 fps and 120 F; $\nu = 6.0[10]^{-6}$ giving $N_R = 0.25[10]^6 = 250{,}000$.)

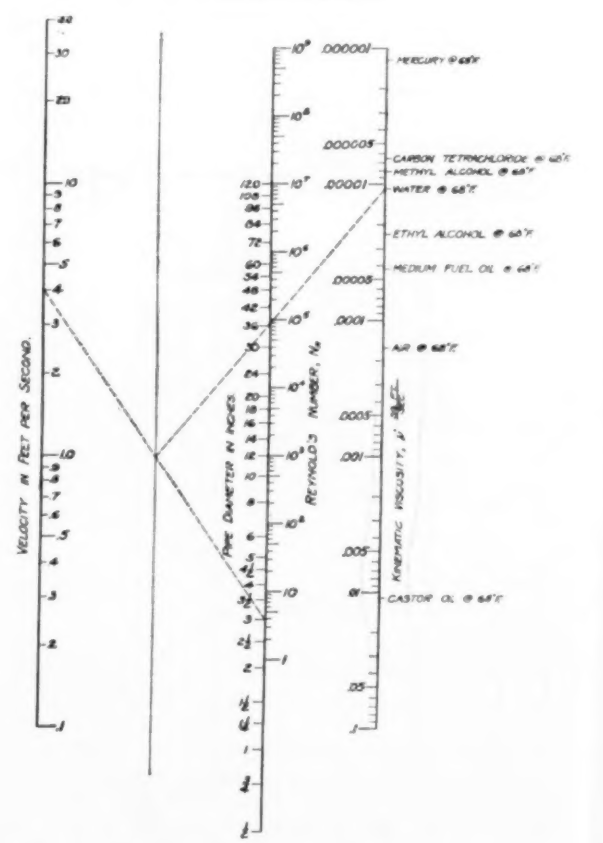

FIG. 2 CHART FOR THE GRAPHICAL SOLUTION FOR REYNOLDS NUMBER FROM THE EQUATION, $N_R = VD/\nu$

(Given a 3-in-diam pipe and a velocity of 4 fps with water at 68 F, the Reynolds number is 90,000.)

Construction of GAS TURBINE *for* LOCOMOTIVE POWER PLANT

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INTRODUCTION

THE gas turbine applied to the service of a road locomotive has been considered for many years by engineers who have been interested in the development of this type of prime mover. One such unit[1] has been built and tested in locomotive service in Switzerland.

In the approach to the problem of designing a locomotive gas turbine, the designer is confronted with a number of features which must be considered throughout the development of the unit. Some of these considerations are as follows, but no attempt has been made to place them in order of their importance:

1 Satisfactory operation on low-cost fuel.
(*a*) Over full range of power output.
(*b*) Over full rotational speed range and train speed range.
(*c*) During acceleration of gas-turbine rotational speed and train speed for increasing and decreasing speeds. During lateral and transverse shock such as are encountered in train operation.
(*d*) When traveling over irregular roadbeds.

2 High availability for service.

3 Weight within limits of desired axle loading without complicated truck arrangement.

4 Adaptability to quantity production to give low cost per horsepower output for such equipment.

5 High efficiency.

6 Low maintenance cost on unit.
(*a*) Long service life of parts.
(*b*) Low cost of replacement parts.
(*c*) Accessibility of parts for repair or replacement.

7 Simplicity of control.
(*a*) Omission of nonessential functions to be performed in the operation of the plant.
(*b*) Co-ordinate the duties of the governor, fuel control, and control of auxiliaries, so that the operation of the plant will require a minimum of attention by the operating crew.

8 Minimum need for water; preferably none.

It is obvious that the most satisfactory locomotive power plant from the monetary and service standpoints is one in which the design is developed to give the best results when performing the assigned work for minimum cost.

With the foregoing specification in mind, a locomotive gas turbine has been designed and is now being manufactured by the author's company for the Locomotive Development Committee, Bituminous Coal Research, Inc. This gas-turbine unit operates on the simple open cycle with regenerator and drives a direct-current generator through gears. Electrical transmission of power to the driving axles allows the use of a well-established transmission system for this service.

[1] "The Brown Boveri Gas Turbine Locomotive," *Brown Boveri Review*, October–November, 1945, pp. 353–367.

Contributed by the Gas Turbine Power Division and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1948, of The American Society of Mechanical Engineers.

PERFORMANCE OF GAS TURBINE

Flow Cycle. The flow diagram, Fig. 1, indicates the sequence of equipment in the cycle with values of gas flows, pressures, and temperatures at various points in the gas path when operating at 1300 F at the turbine inlet with ambient-air conditions of 70 F 14.7 psia and when delivering 4120 hp to the reduction gear.

Since the first application of this unit will be in connection with pulverized-coal fuel, a fly-ash separator is shown in the cycle between the combustor and the turbine inlet.

A total pressure loss at rated load, through the combustor and fly-ash separator of 2.8 psi has been allowed. Pressure losses of 1.2 psi and 0.42 psi through the air and gas side, respectively, of the regenerator have been established to give maximum efficiency of the cycle within the cab space allowable for this equipment.

An initial gas temperature of 1300 F and a pressure ratio of 4.8 was decided upon after considerable study of the influence of gas temperatures and pressures on the life of the highest-temperature parts, and the effect on the efficiency and on the size of components, including the combustor and ash separator.

On the basis of the information in Fig. 1, the unit will deliver 4120 hp to the reduction-gear pinion at 24 per cent shaft thermal efficiency when the combustion efficiency is taken as 96 per cent.

The unit will perform equally as well on fuel oil as on coal. Operation on fuel oil is anticipated during short intervals of time, such as when starting.

If this gas-turbine unit is installed for operation with oil fuel only, a higher efficiency will be realized because of the reduced pressure drop between the combustor outlet and the turbine inlet by reason of the elimination of the ash separator.

Variable-Temperature and Variable-Speed Operation. The unit will operate under three principal conditions of load control as follows:

1 Constant temperature—varying speed.
2 Constant speed—varying temperature.
3 Varying temperature—varying speed.

Constant Temperature-Varying Speed Operation. When the unit operates at constant design temperature and variable speed over its load range, the highest thermal efficiency results for all loads from approximately one-fourth load to full load. This operation is shown in Fig. 2. The efficiency at rated load, temperature, and speed is 24 per cent, while the efficiency at 1000 hp is shown to be 17 per cent at a speed of 3400 rpm. The unit may not be operated below the lowest point shown by the curve unless the initial temperature is reduced, since the pumping range of the compressor is approached at this point.

Constant Speed-Varying Temperature Operation. Fig. 3 shows the efficiency when operating at constant speed and variable temperature over the load range. While the efficiency shown at rated speed, temperature, and horsepower remains at the same value as shown in Fig. 2, it will be noted that at 1000 hp the tempera-

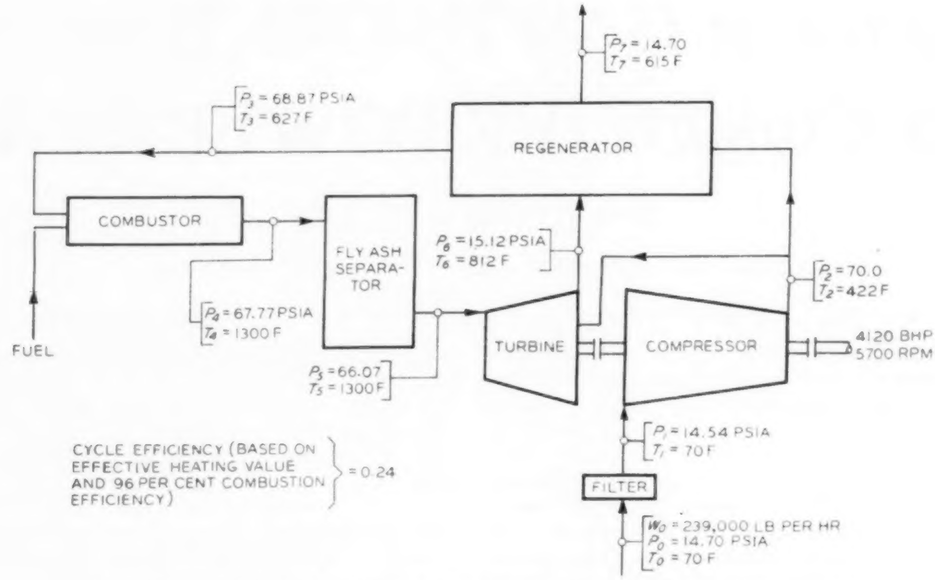

FIG. 1 FULL-LOAD HEAT BALANCE; FULL SPEED AND MAXIMUM TEMPERATURE

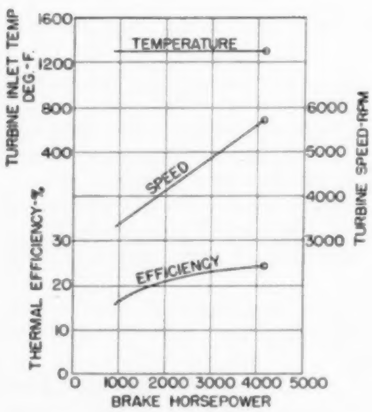

FIG. 2 4100-BHP GAS-TURBINE-PLANT PERFORMANCE DATA; SPEED CONTROL

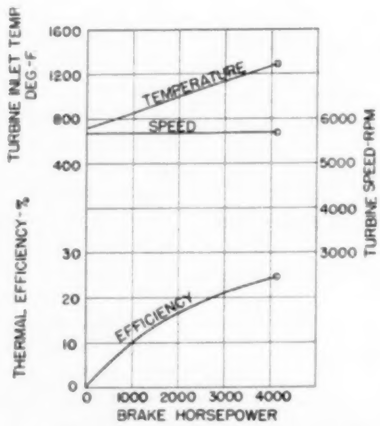

FIG. 3 4100-BHP GAS-TURBINE-PLANT PERFORMANCE DATA; TEMPERATURE CONTROL

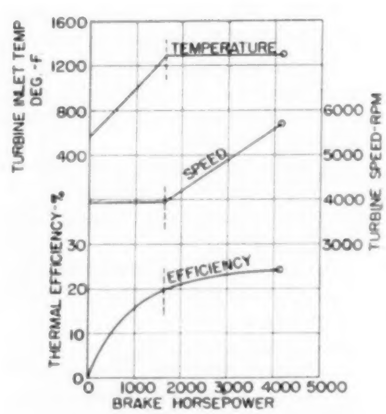

FIG. 4 4100-BHP-GAS-TURBINE-PLANT PERFORMANCE DATA; COMBINED SPEED AND TEMPERATURE CONTROL

ture is only 880 F, and the efficiency has dropped to approximately 10 per cent.

Varying Temperature-Varying Speed Operation. From the foregoing methods of operation, it is clear that in order to have the highest efficiency at light loads the turbine-inlet temperature should be maintained as near to the design temperature as possible. Therefore let us consider Fig. 4 which shows the efficiency decreasing from 24 per cent at rated speed, temperature, and horsepower to approximately 16 per cent at 1000 hp at a speed of 3900 rpm and a temperature of slightly over 1000 F. By comparing Fig. 2 with Fig. 4 we see that better efficiencies can be secured at light loads when the speed is reduced and constant temperature is maintained

By the regulation of the speed and temperature, as shown in Fig. 4, the best over-all operating result is secured.

A description of the controls for this unit is beyond the scope of this paper, but it is opportune at this time to point out that a change in load at constant speed must be accomplished by a change in temperature, while a change in load at constant temperature must be accomplished by a change in speed.

LOCOMOTIVE-GAS-TURBINE COMPONENTS

The gas-turbine unit consists essentially of the following principal components:

Compressor, axial-flow type.

Turbine, reaction type.

Generator, direct-current—two shaft.

Reduction gear, pinion between two low-speed gears which drive main generator shafts.

Regenerator, straight-tube type.

Combustor and fly-ash separator to be furnished by user.

ALIGNMENT

Fig. 5 shows the outline of the gas turbine, compressor, regenerator, reduction gear, and generators as they will be mounted in the locomotive cab.

Since the underframe on which these parts are to be mounted is subject to considerable distortion as the locomotive moves over the track, it has been necessary to mount these parts in such a way that good operation of the unit will continue without being influenced by the frame distortion.

The turbine spindle and the compressor rotor are connected by a stiff coupling in order to balance the pressure forces axially on these rotating elements. Since there is no flexibility provided between the turbine and compressor shafts, the three bearings supporting these shafts must remain in close alignment, regardless of the distortion of the locomotive frame. This is accomplished by mounting the turbine casing, and the no. 1 bearing housing in a cradle *A*, which is bolted rigidly to the end of the compressor (1) containing the No. 2 bearing next to the turbine (2). The cradle is mounted on two supports *B*, which are positioned between the No. 1 and No. 2 bearings and mounted in the cab frame at these points. The compressor casing serves as a beam and is bolted rigidly along a vertical joint *C*, to the cradle. This structure, consisting of cradle and compressor casing, is supported by a cylindrical sliding gib *D*, on the reduction-gear case at the high-pressure end of the compressor. This arrangement results in the desirable three-point mounting (two at *B* and one at *D*) of the turbine and compressor on the cab frame. The generator is mounted on a base which is welded to the cab frame. The main reduction gear is mounted on an extension of the generator base and is bolted rigidly to the end of the generator at *E*, thus maintaining good alignment with the generator. Change in the alignment between the compressor shaft and the reduction gear is taken care of by a flexible arrangement whereby the gear is driven through a quill shaft which passes through the hollow pinion, a construction which has long been used in marine service to perform the same function.

GAS TURBINE

The prime-mover element shown in cross section in Fig. 6 is a six-stage reaction turbine designed to deliver 12,243 hp to the turbine-compressor coupling at a speed of 5700 rpm when the inlet-gas temperature is 1300 F, and compressor air-inlet conditions are 14.7 psia and 70 F.

Spindle. The turbine-spindle body is a fabricated construction, consisting of six equal-diameter disk forgings, which are machined and welded together to form the blade-carrying portion of the spindle. Stub ends are welded to each of the end disks to form the bearing and coupling ends of the spindle. This type of spindle has been used successfully in many types of gas and steam turbines.

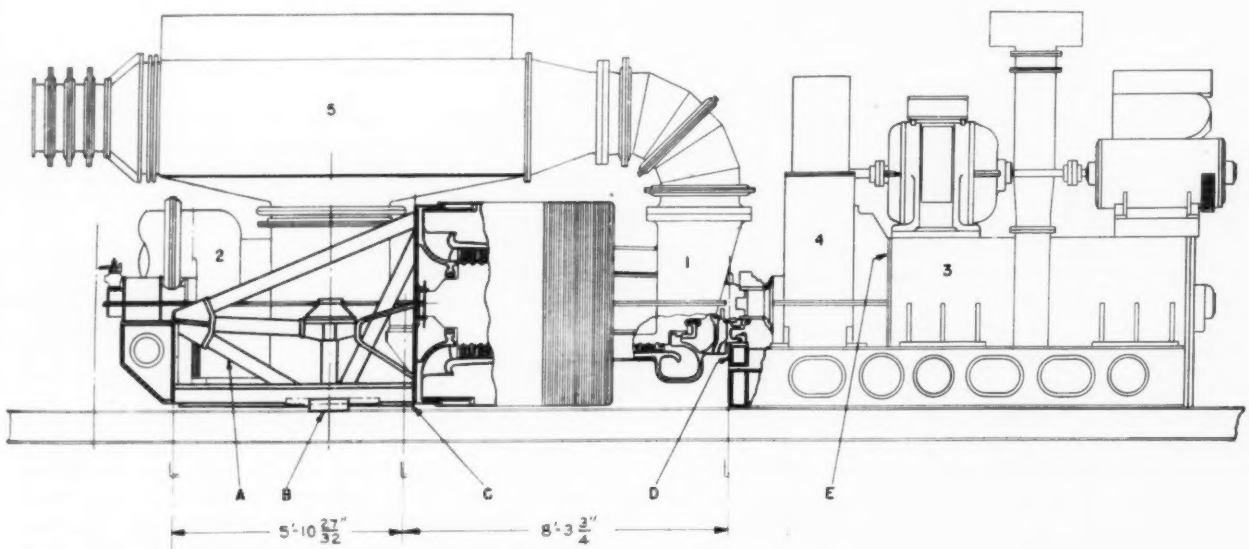

FIG. 5 ALIGNMENT DIAGRAM OF GAS-TURBINE POWER PLANT

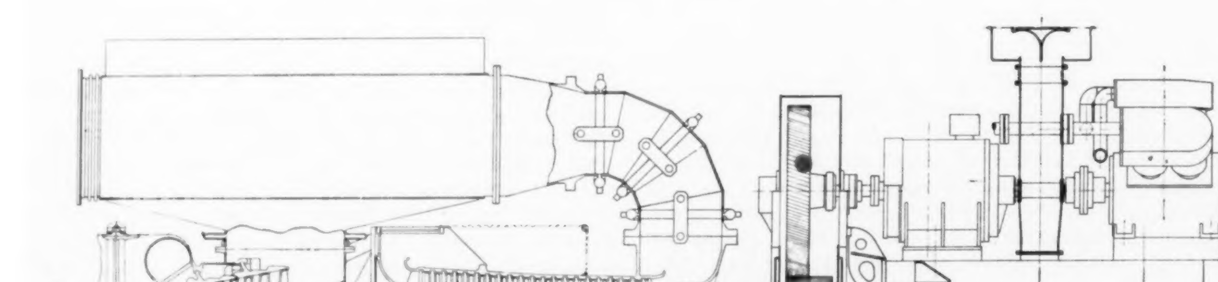

FIG. 6 LOCOMOTIVE GAS-TURBINE POWER PLANT

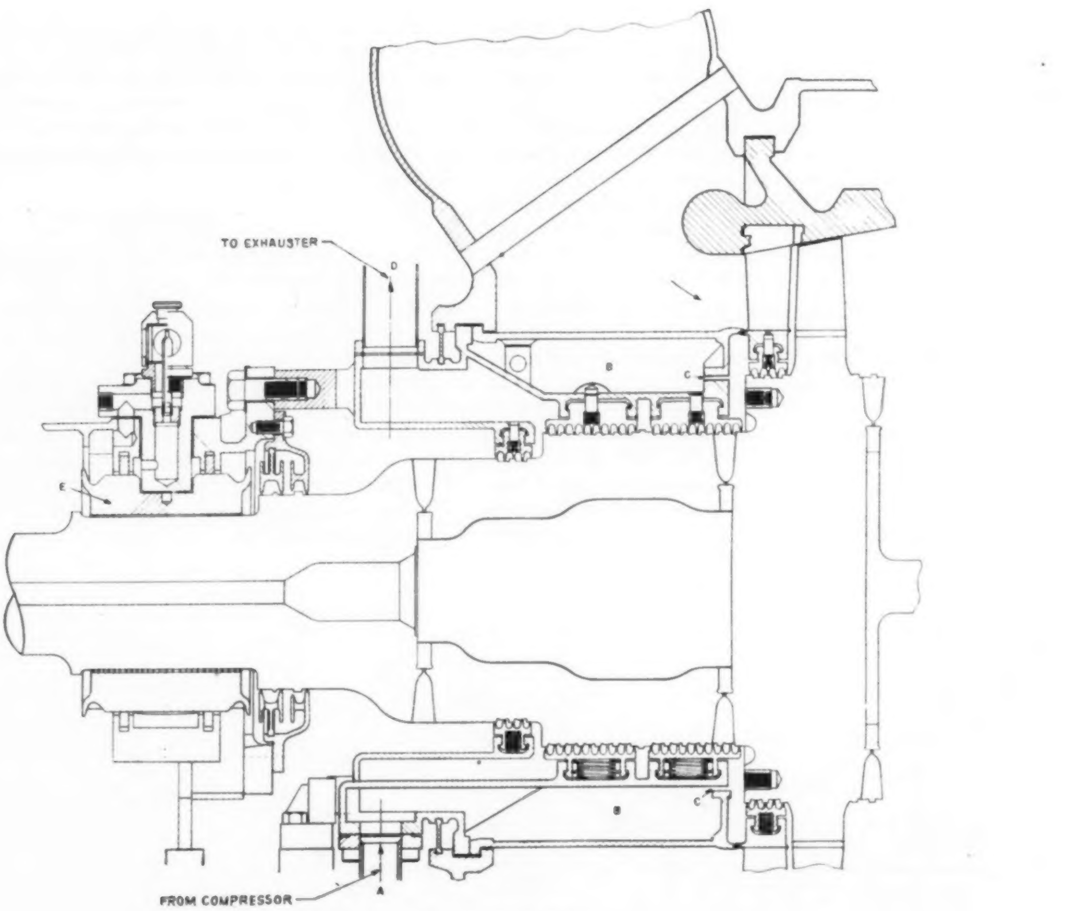

FIG. 7 HIGH-PRESSURE GLAND

The material of the disks and the stub ends exposed to high-temperature gases is Allegheny Ludlum S-590. The basic composition of this alloy is approximately as follows:

	Per cent
Cobalt	20.0
Chromium	20.0
Nickel	20.0
Tungsten	4.0
Columbium	4.0
Molybdenum	4.0

This material was selected primarily because of its physical properties at temperatures of 1300 F and higher. It is expensive because of the high tungsten and cobalt constituents, which are in the category of critical materials. Experience with less expensive materials which are more readily available is promising and may be used in the future when greater experience with the operation of the unit has been accumulated. Supersonic inspection of the metal before and after forging has been an aid in determining the quality of the spindle parts. The integrity of the disk welds will be checked by radiographic inspection. Serrated axial grooves across the circumferential faces of each disk are machined to receive the roots of the turbine-spindle blades.

Cylinder. The cylinder is subjected to a working pressure of approximately 70 psia at the high-pressure end. The outer shell is fabricated from 19-9-DL plates. The cylinder is supported on the cradle at the horizontal joint, and in this way receives no shock forces from other components as they are distributed to the cab frame through the cradle and the central locating pin between the two supports at *B*, Fig. 5.

Each of two cylinder rings of S-588 is rolled to the form of a truncated cone. These horizontally split rings carry the stationary blades in grooves. These cylinder rings are located concentric with the shaft by an arrangement of radial dowels which permits differential expansion to take place without disturbing the relative position of the cylinder rings to the spindle. The turbine cylinder is also split on the horizontal center line.

Blading. The first four rows of blading will be precision-cast while the last two rows will be forged to shape. All blades will be of S-590 material. The roots of the cylinder blades are machined to fit in circumferential grooves in the cylinder rings. The spindle blades will have axially serrated roots to fit the spindle grooves. The tip speeds of the longest and shortest spindle blades are 895 fps and 675 fps, respectively.

The blading is designed to maintain radial equilibrium of flow through all stages. All blades are warped and tapered to a considerable degree and are sufficiently stiff so that bracing wires are not required. No shrouds are used. The blade tips are sharpened to reduce the effect of an accidental blade rub.

Glands. A section through the high-pressure gland is shown in Fig. 7. The purpose of this gland is threefold: (1) to seal the hot gases from escaping between the stationary and moving parts at the high-pressure end of the cylinder; (2) to cool the turbine spindle at this point in order to reduce the maximum temperature of the rotating element; and (3) to reduce the temperature of the turbine spindle at the adjacent bearing journal, *E*.

Air from the compressor discharge, which is at a higher pressure than the inlet to the first stage of the turbine because of the pressure loss through the regenerator and combustion system is admitted at *A*, to a belt around the gland as shown by *B*. This total flow of air passes through the circumferential opening at *C*, and a portion of it enters the turbine gas path at the entrance to the first spindle row of blading by passage through the labyrinth at the first stationary row of blading. This quantity of air being much cooler than the air entering the turbine inlet will keep this portion of the spindle in this high-temperature region cooler than it would otherwise be and thereby increase the life of these high-temperature parts.

A further amount of compressor-discharge air flows through the gland labyrinth packing along the surface of the turbine spindle and out at *D*, to the suction of a small exhauster fan.

This arrangement creates a flow of relatively cool air along the turbine spindle from the bearing oil baffle to the root of the first moving row of blading, thus (1) avoiding the escape of hot gases into the locomotive cab, (2) cooling the highest-temperature part of the spindle to give longer life, and (3) avoiding high metal temperatures at the adjacent bearing *E*.

The low-pressure labyrinth gland is of similar construction but only a sufficient amount of compressor discharge air is introduced in order to avoid hot exhaust gases being discharged against the bearing at the low-pressure end of the turbine.

Bearings. The main turbine and compressor bearings are designed in accordance with the general principles of sleeve-bearing construction commonly used in steam-turbine practice and will not be further described here.

Thrust Bearing. The Kingsbury-type thrust bearing is located in the bearing housing at the high-pressure end of the turbine and maintains the axial position of the turbine spindle relative to the cylinder by a steel rod on either side of the bearing, which transmits the motion of the turbine cylinder directly to the thrust bearing. Since the turbine spindle and compressor rotor are joined by a flange coupling, and the turbine cylinder is held in position relative to the compressor cylinder through the cradle, the proper relative axial position of the compressor rotor and cylinder are also maintained.

COMPRESSOR

The compressor is of the axial-flow type and is placed between the turbine and main reduction gear. This arrangement allows sufficient space for a regenerator to be placed in the cycle in a position above the turbine and compressor. This type and size of compressor has demonstrated, by many tests, that it is capable of operation with efficiencies exceeding 85 per cent.

Rotor. The compressor rotor body, Fig. 6, with an integral stub end at the high-pressure end is made from a single forging. The stub end at the low-pressure end is also made from a forging and is bolted to the low-pressure end of the rotor body and located with a forced centering fit. This simple method of rotor construction has been used extensively for large steam-turbine spindles and axial-flow compressors.

After complete machining, the rotor body is grooved circumferentially to receive the compressor blades

The low-pressure stub end has an integral flange for coupling to the turbine spindle. The high-pressure stub end also has an integral flange for coupling to the gear-quill shaft through which the net power output of the gas-turbine unit is delivered to the driving pinion.

As previously mentioned, the axial-pressure thrust on the compressor rotor is opposed by the axial thrust on the turbine spindle. The thrust bearing maintains the axial position of the turbine spindle and compressor rotor relative to the stationary parts.

Casing. The upper and lower halves of the compressor casing are fabricated from shaped steel plates and are circumferentially grooved to receive the stationary compressor blading. Since the steel compressor casing is bolted rigidly to the turbine cradle and acts as a beam between the two supports under the cradle and the one support on the gear casing, the casing is stiffened by several longitudinal ribs welded to the outside of the casing.

Blading. The twenty rows of compressor moving and stationary blades are mounted in circumferential grooves in the rotor and casing.

All blades have integral spacers and will be precision-cast with accurately machined roots for fitting in the grooves.

LUBRICATION SYSTEM

The lubrication system is forced-feed to all gas-turbine, compressor, gear, and generator bearings.

The main oil gear pumps are driven by the main reduction gears, and an auxiliary motor-driven pump is arranged to start automatically if the oil pressure falls below a predetermined amount. The motor driving the auxiliary pump receives its electrical power from the locomotive battery.

The lubricating oil is cooled by a suitable radiator with a motor-driven fan to secure the necessary rate of heat transfer. This oil-cooler installation will be similar to present practice on Diesel locomotives.

An oil tank under the main reduction gear will provide ample capacity for the lubrication system.

GOVERNOR

The flyball-type speed-control governor is driven from the main reduction gear. This governor operates in conjunction with the control system to maintain the desired speeds by controlling the rate of fuel flow to the combustors on the low-speed range and by controlling the excitation when operating on the constant-temperature phase.

A radial-action overspeed governor is provided to stop the flow of fuel to the combustors.

TURNING GEAR

In order for the gas turbine to be available for quick starting after shutdown, a turning gear, located in the bearing housing between the compressor and the reduction gear, will maintain proper thermal equilibrium by turning the rotating elements periodically. The turning gear works on the pawl-and-ratchet principle and requires only a small amount of electrical power for operation.

REGENERATOR

The regenerator is shown in position above the turbine in Fig. 5. The size of the regenerator is based upon space available between the roof of the cab and the exhaust nozzle of the turbine. Also, the width was established by the space available after satisfactory aisle widths on each side of the cab were allowed. An end view of the unit, Fig. 8, shows the minimum aisle clearances in the locomotive cab.

The high-pressure air is carried through the regenerator in straight tubes, while the hot exhaust gases pass over the tubes and are exhausted through the cab roof to the atmosphere. The tubes are rolled into tube sheets at either end of the regenerator, and the difference in expansion between the length of the shell and the length of the tubes is taken care of by a steel expansion joint at one end of the regenerator shell.

Steady plates spaced between the tube sheets eliminate vibration and hold the tubes in place.

GENERATOR

Since the weight of the gas turbine must be held to a minimum

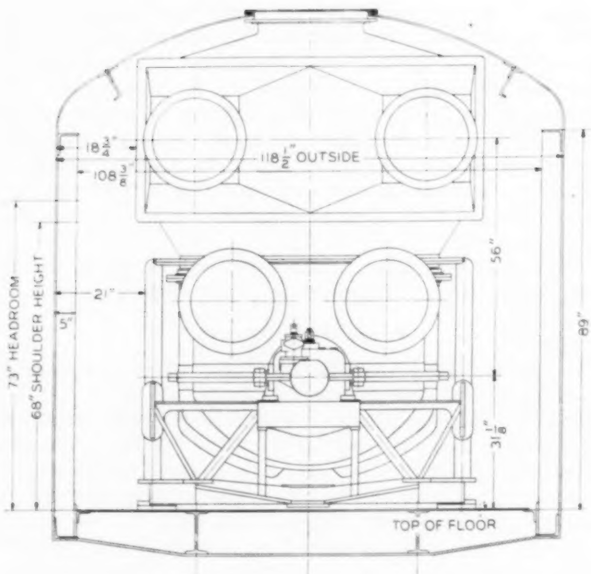

FIG. 8 SECTION THROUGH LOCOMOTIVE CAB

for good design practice, a number of arrangements were studied to determine the arrangement which would (1) give a symmetrical weight distribution over the width of the cab, (2) have minimum weight within limits of high order of reliability and low order of maintenance, and (3) occupy minimum volume in the cab.

The results of this study indicated that a two-shaft generator having two armatures on each shaft would result in a symmetrically arranged generator assembly with respect to the longitudinal center line of the turbine, gear, and cab. The height of such a generator is low so that four of the locomotive auxiliaries are mounted on top and driven from the main reduction gear as shown in Fig. 6. With this arrangement, it was decided to operate the generator shafts at 1350 rpm. Further study showed that these shafts could be operated at 2000 rpm with considerable saving in weight without exceeding established practice for commutator speeds. This has been decided upon for this service.

REDUCTION GEAR

Referring again to Fig. 6, the high-speed pinion operating at rated turbine speed of 5700 rpm is located between a driven gear on each generator shaft turning at 2000 rpm. The following locomotive auxiliaries mounted on top of the generator are driven from the main gear and operate also at 2000 rpm:

Two 175-kw alternating-current generators.
One 30-kw regulex exciter.
One 40-kw direct-current generator.

STARTER

The unit will be started by two of the four main generators acting as motors to bring the unit up to starting speed of approximately 1600 rpm. Power will be supplied by the locomotive battery or by a 200-hp Diesel-driven generator which will be located in the auxiliary cab.

SUMMARY

A great deal of space might have been devoted to the complex considerations which are involved in the commercial phases of the project. It will not be out of order to summarize briefly some of the main reasons why this development is considered important in our national economics.

1 The use of soft coal of ordinary railroad grades will make possible the operation of gas-turbine locomotives with a fuel cost of something less than one half that required for the Diesel locomotives, and a still smaller percentage of the cost of fuel for conventional steam reciprocating units.

2 It is predicted that locomotive plants of the type described will operate with a substantially lower maintenance than now found necessary with present types of locomotive power.

3 It is predicted that the cost of prime-mover elements necessary to the coal-burning gas-turbine locomotive will be well within the range necessary to make such installations very attractive to prospective users.

4 Material economies during a state of war would possibly preclude the use of liquid fuels for heavy traction. The gas-turbine locomotive, with its ability to burn ordinary grades of railroad coal at good efficiency, should prove to be a most desirable prime mover under conditions of severe fuel rationing.

Coal-Burning Gas-Turbine Locomotives

THE coal-burning gas-turbine locomotive is most serious competitor to the presently popular Diesel locomotive that has yet appeared on the railway scene, according to an address presented by Dr. John T. Rettaliata at the Annual Indiana Coal Conference, Terre Haute, Ind. Dr. Rettaliata, Mem. ASME, is dean of engineering, Illinois Institute of Technology, Chicago, Ill. He said that unquestionably the numerous advantages of the Diesel engine make it a very desirable type of power plant for locomotive use. However, it is believed that the gas turbine, especially when using coal as a fuel, possesses even more beneficial characteristics when applied to the heavy traction field, and it is predicted that only by its adoption will the ultimate in locomotive design be achieved.

A 4000-hp coal-burning locomotive gas turbine now being constructed will soon be ready for testing, and if the anticipated performance is realized, fuel and maintenance costs will be lower than for any other locomotive ever built. A direct-current type of electric transmission, similar to that used in Diesel-electric locomotives, will be employed.

The gas-turbine power plant consists of a turbine driving directly a compressor and, through a reduction gear, also a generator, the latter furnishing electric power to traction motors mounted on the axles of the locomotive. Air from the atmosphere has its pressure increased by the compressor and, after passing through a combustion chamber where its temperature is raised to about 1300 F by the burning of pulverized coal, enters the turbine in the form of a hot gas. By expansion of the gas through it the turbine develops more power than the compressor requires so the excess goes to the generator. A heat exchanger will also be employed so that the turbine exhaust gases, which would otherwise be wasted, can be used to preheat the compressed air before it enters the combustion chamber.

The expected fuel cost, when using coal, will be approximately one half of that of a Diesel locomotive of similar horsepower, Dr. Rettaliata stated. The lubrication costs should not exceed one tenth of those of the Diesel type. The purely rotary motion of the gas turbine will result in minimum maintenance and vibration. Absence of any reciprocation, with its concomitant unbalanced forces, is obviously beneficial. Several other gas turbines, of a design similar to that of the locomotive unit, have operated in oil refineries for continuous periods as long as several years without shutdown; thus indicating the reliability to be expected from the locomotive gas turbine.

COCKPIT-DESIGN PROBLEMS

Of High-Altitude High-Speed Aircraft

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DURING the past few years, it has become increasingly evident that we are on the threshold of building airplanes which we cannot fly, at least to the extent of the full capabilities of the airplane,without certain equipment and devices, the use of which even then will penalize the airplane performance-wise. In recent years, advancements in the art of aeronautics have been nothing short of remarkable, and yet, the present high-performance airplanes are being flown by men who are little changed over their great-great-grandfathers who drove oxcarts. While space was not at a premium in the oxcart, it certainly is in the cockpit of a jet fighter, yet the fighter pilot takes up as much space as the oxcart pilot, maybe a little more.

Man, however, does not improve the way the airplane does, and worse than that, he shows little promise of doing so. He will die if hit on the head with the same-size rock which would have killed a man a thousand years ago. He complains if he gets too hot or too cold. In addition, he passes out if the airplane maneuvers too violently, or if he is not provided with oxygen. He gets lost. He gets tired and loses his ability to concentrate, and he has nowhere near the sensitivity and rapidity and precision of response which the airplane designers foresee as necessary in the future.

It is true that the human pilot is being scientifically and objectively studied, and that aviation medicine is producing amazing new facts every day as to his limitations and how to get the most out of his capabilities. However, when all is said and done, he will still fall far short of what the airplane designer would like to get from him. Hence careful consideration must be given to designing the airplane to fit the pilot.

While many of the problems associated with high-speed flight overlap those associated with high-altitude flight, they can, for purposes of discussion, be broken down into separate classes.

HIGH-ALTITUDE FLIGHT

The operational altitude of the airplane is constantly increasing, and has been constantly increasing, ever since the Wright brothers made their first flight. The World War I airplane usually operated at altitudes below 5000 ft. In World War II, operations were conducted at altitudes as high as 38,000 ft. There are many reasons why we keep trying to increase the service ceilings of our airplanes. From an operational viewpoint, high altitudes are desirable to reduce hazards from anti-aircraft fire, weather, the topography of mountainous country, and to take advantage of favorable winds. The fighter aircraft must of course be able to fly as high as the bomber, for in combat the plane on top usually has the advantage. The advent of the jet engine also has spurred high-altitude flying, since this type of engine operates more economically at altitude.

While there are many people in the world who have spent all their lives at altitudes in excess of 10,000 ft, man is basically a sea-level creature. It has been pretty well established that the average individual begins experiencing difficulty after exposure for prolonged periods at altitudes of 10,000 ft; at 15,000 ft, he can get along but in a very inefficient state; prolonged exposure at 20,000 ft is almost certain to result in death. Based upon these conditions, Navy pilots are instructed to use oxygen in all daytime flights over 10,000 ft when oxygen is available. Flights above 10,000 ft without oxygen may be made only in case of emergency, or for purposes of flight safety. For night operations, oxygen is recommended for all flights above 5000 ft. This is due to the fact that side vision begins to drop off sharply at about 5000 ft when oxygen is not used.

OXYGEN BREATHING APPARATUS

The oxygen system most commonly used in naval aircraft is the diluter-demand system. The diluter-demand regulator is designed to meet the demands of the inhalation phase of the breathing cycle and to deliver either a properly proportioned mixture of air and oxygen or 100 per cent oxygen, depending upon the setting of the adjustable air-valve lever. The air-oxygen mixture is controlled automatically by an aneroid unit and provides the user with sufficient oxygen to maintain the blood oxygen content at normal levels. However, as the transfer of oxygen through the lungs into the blood is dependent upon the atmospheric pressure, the present oxygen equipment will maintain the blood oxygen content at normal levels only to about 33,000 ft, at which point the regulator is supplying 100 per cent oxygen. Above this altitude, even though breathing pure oxygen, the blood oxygen content gradually decreases so that, at 40,000 ft, it is approximately equivalent to what it would be at 10,000 ft when breathing air.

Altitudes from 33,000 to 40,000 ft may be safely attained only if the oxygen mask is so worn that no leaks are possible. Above 40,000 ft, in order to maintain the blood oxygen content above a dangerous level, the oxygen pressure within the lungs must be increased above the ambient level. This may be done by pressurizing the cockpit, or by the use of pressure-breathing oxygen equipment. It must be realized, however, that pressure-breathing equipment does not maintain the entire individual at an altitude lower than ambient. As a result, personnel, using pressure breathing only, may become subject to the "bends," This is a painful condition caused by bubble formation in the joints. Bends are usually associated with diving, but are just as painful and incapacitating to the pilot as to the diver.

COCKPIT PRESSURIZATION

It would appear that cockpit pressurization would be the answer to all of our high-altitude problems. Unfortunately it is not, for several reasons. Pressurizing the cockpit does not entirely eliminate the oxygen requirement because of another factor known as explosive decompression. Explosive decom-

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NOTE: The opinions or assertions contained herein are those of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

pression is said to take place when the pressure inside the cockpit instantaneously drops to and is equalized with the outside air pressure. This may occur when the enclosure is inadvertently lost or the airplane is struck by gunfire.

If decompression is from a fairly high pressure to a low pressure, the resultant expansion of gases in the pilot's lungs, stomach, and intestines is apt to cause tissue damage with gastrointestinal and pulmonary hemorrhage. This is just as bad as it sounds. Aviation medicine tells us that the critical thing about explosive decompression is the ratio of the ultimate to the initial gas volume, and that this ratio must not exceed 2.3. In other words, the gases in the body can expand as much as 2.3 times their normal volume without doing permanent damage to the average pilot. This means that there is a certain limiting safe differential pressure for any airplane. The value of this safe limit depends upon the volume of the pressurized space and the size of any anticipated opening which may release the compressed air in the cabin.

In single-place combat aircraft, the Navy limits the cabin differential pressure to 5 psi at 27,500 ft, which provides a simulated cabin altitude of 10,000 ft. Above 27,500 ft altitude, the differential pressure must be reduced further so that, at an altitude of 50,000 ft, it becomes 1 psi, resulting in a simulated cabin altitude of 40,000 ft. This will protect the pilot from bends, but of course is far above the altitude at which he must start using his oxygen mask.

Also, we start paying a weight penalty for cockpit pressurization. Not only is the weight of the equipment (compressor, controls, and other equipment) added to the weight empty of the airplane, but the weight of the fuselage and pilot's enclosure is increased with the structural and sealing provisions necessary to provide an airtight cockpit. Needless to say, weight is the mortal enemy of high-performance aircraft, and even a pound increase causes the airplane designer great anguish.

Furthermore, cockpit pressurization results in a more complicated airplane. This means increased first cost, increased maintenance, and, although the operation is mostly automatic, it is just one more item for the already overburdened pilot to worry about.

At high altitudes, with resultant low temperatures, it is of course necessary to keep the pilot warm. The most desirable way of accomplishing this is to heat the cockpit or cabin. Cockpit heat is one item which, fortunately, we can get at a very low price in many of our airplanes; although we sometimes have to pay plenty to get rid of it, as will be discussed later. In single-place aircraft with pressurized cockpits, the quantity of heat in the ventilating air after it leaves the compressor is usually sufficient to raise the cockpit temperature to 75 F with an outside air temperature of —65 F. In larger cockpits, it is necessary to provide supplementary heat. The most satisfactory way of doing this, or at least the most practicable method known to date, is by means of combustion heaters.

ABANDONING AN AIRPLANE AT HIGH ALTITUDE

Once the airplane is flying along several miles in the air with the pilot warm and comfortable, breathing an adequate supply of oxygen, and with sufficient pressure in the cockpit to prevent the bends, the designer, on first thought, may consider that his job is finished. Picture the look of consternation on his face when he suddenly realizes that he must accept at least part of the responsibility of getting the pilot, and flight crew, back to the ground—without their airplane. We know that in military aircraft this will sometimes be necessary. Consequently, we must make provisions for it.

When the pilot leaves his airplane at high altitude, he is, in effect, stepping out into space. There may be insufficient oxygen to sustain life. In fact, if he is at an extremely high altitude, he cannot delay opening his parachute and fall free to a lower altitude before he dies. Even though he takes his oxygen supply with him, he may die from exposure unless properly protected. A broad study of this problem has indicated that the most desirable way (and at high altitudes probably the only way) the pilot can effect emergency escape is by means of what is commonly called an escape capsule. For single-place aircraft, this capsule might be either the cockpit itself or the nose section of the airplane. It might be possible for the pilot to remain in this capsule until he reaches the ground; or, if the weight involved required too large a parachute, he could abandon the capsule in a conventional manner at some comparatively low altitude. It is attractive to consider the pilot remaining in the capsule until he reaches the ground. If over water, the capsule might act as his boat. In any event the pilot would not have to wear a parachute and survival equipment which could be stored in convenient locations around the cockpit area. The elimination of the parachute and survival gear from the seat would greatly simplify seat design and result in a much more comfortable seat.

The pilot forced to escape from an airplane in an emergency is faced by dangers other than those due to altitude. Centrifuge tests have indicated that the average person in unable to move directly against a centrifugal force of more than 2 or 3 g and that at 4 g any effective movement becomes virtually impossible. These are rather moderate accelerations and can be reached or exceeded readily when the airplane is spinning or in an uncontrolled maneuver resulting from structural failure, gunfire damage, and the like. It might be added that, in the aviation field, it is common to speak of accelerations in multiples of the acceleration of gravity. For example, a 4-g acceleration is an acceleration equal to 4 times the acceleration of gravity. If the pilot succeeds in getting out of the cockpit, he may strike the empennage and, at the higher air speeds, he may be seriously injured by the wind blast alone. It is felt that the conventional method of bail-out to effect escape in an emergency is limited to approximately 300 mph indicated air speed.

DEVELOPMENT OF EJECTION SEATS

While the escape capsule is our long-range objective, we are faced with the necessity of providing some mechanical means of escape for airplanes that are now flying or will soon be in the air. To meet the needs of these airplanes, ejection seats are being developed. The Germans recognized the need for such a seat back in 1939, when they realized that operational jet airplanes were a definite possibility. After much experimental work, they equipped certain of their service-type airplanes with a rather crude ejection seat, and at least 60 successful emergency escapes are known to have been effected with this seat. After investigating various means of propelling the seat out of the airplane, the Germans selected a powder charge over pneumatic and hydraulic actuators because of weight and space considerations. The final vertical velocity of the German seat was only about 25 fps, which is now considered low, and the "jolt factor" was high. The jolt factor is the term that is used to express the condition of high upward forces applied for fleeting intervals of time at the start of the ejection stroke.

The development work started by the Germans was continued by the British during the latter part of the war. The Navy subsequently contracted with one British company, the Martin-Baker Company, for certain design data and test equipment, including a 105-ft-high ejection-seat test tower (see frontispiece of this issue), test seats, and experimental seat catapults. This equipment has been in constant use since its

arrival at the Naval Air Material Center in Philadelphia, and has been instrumental in the development of ejection seats for naval aircraft.

The acceptable ejection seat must provide the seat and occupant with sufficient vertical velocity to clear the tail of the airplane without subjecting the occupant to dangerously high accelerations during the ejection stroke. In order to obtain data on the physiological and mechanical factors involved during acceleration of the seat, numerous closely controlled tests were conducted at the Naval Air Material Center on the Martin-Baker test tower. Both instrumented dummies and human subjects were "ejected" on the tower, and the characteristics of different catapult combinations were determined.

To obtain accurate measurements of accelerations during the ejection, accelerometers were placed at various points on the subject's body as well as on the seat structure. The pressure within the catapult was measured and the vertical velocity of the seat was recorded. These experiments indicated that much higher accelerations may be recorded in the subject than on the seat. This is due to the fact that, when a force is rapidly applied to an elastic mass, such as we have when a man is sitting on a seat cushion, a dynamic response is initiated in the mass. The displacement or acceleration, at a given point, may range from equal to the average for the mass when the force is applied statically, to twice as great when applied instantaneously.

The ideal catapult would reach the maximum ejection force consistent with human safety in the minimum time required to avoid exciting a significant dynamic response, and would then maintain this force through the remainder of the ejection stroke. All points on the seat and occupant would accelerate uniformly with a resultant maximum response factor of 1. The catapult which has been designed by the Naval Air Material Center for use in naval aircraft was designed on this basis.

During the tests at the Naval Air Material Center, a comparison was made between the face curtain and arm rests as a means of decreasing stress on the spinal column during the time the catapult is accelerating the seat. All subjects could comfortably withstand approximately 6 g more with the face curtain than with the arm rests, and it was much preferred.

DETAILS OF EJECTION SEAT

The ejection seat, in each Navy airplane for which it is specified, is being designed by the airplane contractor in accordance with a Bureau of Aeronautics specification. Consequently, there may be slight variations between the seats in different model airplanes, although the seats are basically the same.

The ejection seat essentially is a typical high-strength short-range pilot's seat, equipped with foot rests and a special headrest. The headrest contains a fabric curtain rolled up on a spring-loaded roller. In the ejection process, the pilot grasps handles in the forward edge of the curtain and pulls it down over his face. This curtain permits the pilot to support part of his weight by his arms, as previously mentioned. It also protects the face from wind blast and holds the head back against the headrest, maintaining the body in an erect position.

The catapult consists of a cylinder attached to the airplane structure and a piston attached to the seat. The powder charge is in a cartridge mounted in a breech at the top of the piston tube and is fired by a spring-loaded firing pin which is actuated by pulling the face curtain. The seat is guided along a predetermined trajectory by two guide rails on which it is mounted. As soon as the seat has cleared the airplane, a small drogue parachute is opened. This parachute serves two purposes, it decelerates the seat and it also stabilizes and prevents it from tumbling. When the seat has decelerated to a safe speed, the pilot unfastens his lap belt and shoulder harness, leaves the seat and opens his conventional parachute.

PROBLEMS OF DESIGN OF AIRCRAFT ASSOCIATED WITH EJECTION-SEAT DESIGN

A great deal of time, effort, and money have been spent in developing the ejection seat to the point where it appears to offer a practicable means of emergency escape from the conventional cockpit. Although it is believed that adequate information has been obtained on the basic factors involved, it is also realized that there are many problems in the actual design of the seat installation for a given airplane.

The ejection seat complicates the clearance problem in the cockpit. Space in a single-place high-speed airplane is already at a premium. When an ejection seat is installed, additional space must be provided between the seat back and the windshield and instrument panel to insure clearance for the pilot's knees during ejection. However, this increase in distance between the seat and the windshield and instrument panel is undesirable from the standpoint of viewing and reaching the instrument panel and the gunsight. Therefore, care must be taken to insure a satisfactory compromise.

The relative operation between the sliding section of the enclosure and the ejection seat also must be controlled closely. To insure that the enclosure is open before the seat is ejected, the controls for firing the seat catapult must be interconnected with the enclosure.

The seat must of course incorporate the normal provisions for lap belt and shoulder harness, as well as for the seat-type parachute and pararaft kit. It must be comfortable, and adjustable throughout a range that will accommodate all pilots who may fly the airplane; and it must have sufficient strength to withstand any accelerations up to 40 g that may occur in a crash.

During normal flying, there are several connections between the pilot and the airplane. These include the oxygen line, wires for headphones and transmitter and the antiblackout suit supply line. These must all be disconnected before it is safe to eject the seat. We are developing a single unit that will include connections for all of these lines and which will permit all lines to be disconnected automatically before ejection.

In addition to making provisions for the pilot to eject himself readily in an emergency, the designer also must incorporate safety measures to insure that the pilot or some member of the ground crew is not ejected inadvertently when the airplane is on the ground. Naturally, we have given considerable thought to this possibility, and several methods for reducing the probability of accidental firing of the seat catapult have been considered. Our first thought was to have the pilot remove the cartridge upon landing and reinstall it prior to flight; but the more consideration we have given to this method the less attractive it appears. Such a procedure is bound to result in a few cases of the pilot taking off with the catapult unloaded. Also, it is the unloaded gun that always shoots someone. Our present thinking is to leave the cartridge in the catapult at all times and attempt to prevent accidents by careful indoctrination and training of the personnel who will be associated with the seat.

ENCLOSURE-DESIGN PROBLEMS

The cockpit enclosure on most carrier airplanes is of the "bubble" type, formed of noninflammable, transparent, sheet plastic. The enclosure is opened and closed by sliding the bubble fore and aft on tracks. While there are many difficult design and fabrication problems associated with this arrangement, as yet we have not found a satisfactory substitute for the sliding type of enclosure for carrier operations. This is be-

cause the carrier pilot likes to land and take off with his enclosure open. His desire is understandable when it is recalled that, in the event of a landing or take-off accident, he is quite likely to end up in the middle of the ocean. Under such conditions an enclosure over his head can mean the difference between a ducking and a fatal accident. A fatal accident will also result if the pilot cannot get his enclosure open for emergency escape in the air.

Most wartime airplanes incorporated enclosures that could be jettisoned in flight. These installations were found to be extremely dangerous due to the erratic path that the jettisoned portion of the enclosure might follow when released. In some cases it would whip through the cockpit, striking and seriously injuring the pilot. Also, numerous cases were experienced of accidental jettisoning of the enclosure. This was due to the fact that the release mechanism was necessarily of a hair-trigger nature to enable it to be tripped readily by the pilot when high aerodynamic forces were acting on the enclosure.

After much consideration of the problem, jettisoning of the enclosure was abandoned in favor of opening the sliding section along its regular tracks for emergency exit. In most of our present airplanes, the sliding section is opened and closed by a power actuator either of the hydraulic or electric type. In addition, a completely separate source of power, such as an air bottle, is provided for opening in an emergency.

The aircraft designer is becoming increasingly apprehensive about the use of transparent plastics in the cockpit enclosures of high-altitude high-speed aircraft. One reason for this concern is the questionable ability of the conventional acrylic plastics to withstand the temperatures resulting from aerodynamic heating at speeds in the sonic region. Another reason is the tendency for these materials to shatter on impact, a disadvantage under any circumstance, but especially serious when the cockpit is pressurized.

Some improvement in the heat resistance of transparent plastics has been realized, and further improvements should be possible. There has been some minor improvement in shatter resistance in the form of a laminated acrylic plastic, but the improvement is confined to such a narrow temperature range and is accompanied by so many disadvantages that little use of this material is indicated. Unfortunately, it has not yet been possible to develop a transparent plastic combining any significant improvements in both heat resistance and shatter resistance. The outlook of such a development in the near future does not look too encouraging.

In the face of these limitations of the acrylics, increasing attention is being focused on laminated glass. This material, however, is not without its own limitations; not the least of which is its heat resistance, which is governed primarily by the thermal properties of the plastic interlayer used to prevent shattering of the glass on impact. The development of a substantially superior interlayer material cannot be anticipated for a number of years.

Pending the long-range development of markedly improved transparent materials, it is evident that presently available materials, with possible minor improvements, will have to be used in airplanes now being designed. The accommodation of these materials to the rigorous enclosure requirements imposed by speeds in the sonic range and by cabin pressurization obviously renders the design problem more complex than it has been in the past with relatively slower nonpressurized aircraft. In view of the thermal limitations of the currently available transparent materials, the inclusion of special cooling provisions in future high-speed enclosure designs is not inconceivable. This of course would not be applicable to solid plate glass for the range of speeds under consideration; but it is not probable that solid plate glass will be used because of its shattering characteristics. It also appears that due to manufacturing considerations, a built-up multipanel construction may be necessary for cockpit enclosures utilizing laminated glass. The design of built-up enclosures will entail balancing the risk of explosive decompression against the risk of panel failure and the adverse effect of the necessary framing on visibility in determining panel size. The framing itself presents a design problem in that it must be sufficiently rigid to resist all applied loads without distortion which might precipitate failure of the panels.

All of these considerations serve to emphasize the importance of the design factor in the construction of suitable enclosures for high-altitude high-speed aircraft. The material, structural, optical, aerodynamic, and mechanical problems must all be coordinated and balanced if satisfactory performance of the installation is to be achieved.

COCKPIT COOLING

Reference to the thermal considerations in enclosure design, no doubt, have caused some question of how the pilot is faring when his enclosure is about to melt off the airplane. It is obvious that under such conditions the cockpit must be cooled. Aircraft-cockpit cooling is the opposite of heating. However, it is more recent in origin; is more difficult to accomplish and is less well understood. At first thought it may not be apparent why the cockpit of an airplane might need to be cooled, although the necessity for heating it is usually taken for granted, just as it is more common to heat a house than to cool it. In the case of houses, however, summer air conditioning, of which cooling constitutes one aspect, is a luxury rather than a necessity; whereas, in the case of high-speed aircraft, cooling is an absolute necessity.

Inasmuch as the purpose of the cooling system is to offset or neutralize the heat which flows into the cockpit, the first step in the design of the system is to estimate the amount of this total rate of flow of heat as well as its manner of variation with flight altitude, airplane speed, season of the year, hour of the day, and the like. The cooling load is, by definition, the maximum expected rate of flow of heat into the cockpit from all sources. For convenience this heat flow may be broken up into five parts; skin heat, solar heat, electric heat, body heat, and sensible heat in the ventilating air.

Skin heat refers to the rate of flow of heat into the cockpit through side walls, fore-and-aft bulkheads, floor, and canopy by conduction. For a given amount of cockpit-wall area, it is the product of the area, temperature difference and over-all heat-transfer coefficient. The general method of computation is the same as in industrial air conditioning. In some respects it is easier to evaluate, and in others more difficult, than in the industrial field. One simplification in aircraft work comes from the fact that the airplane fuselage is simpler, from a heat-transfer point of view, than a building structure. One complicating element comes from the fact that the over-all heat-transfer coefficient is not independent of altitude, but tends to diminish with increasing altitude, owing to decreasing air density and also with decreasing indicated airplane speed, which decreases with increasing altitude. At a given altitude, the heat-transfer coefficient increases with airplane speed due to the kinetic or aerodynamic heating of the outer surface.

The solar-heat component of the cooling load includes both direct solar irradiation on the enclosure from above and nocturnal irradiation, which is the radiant heat received by the airplane from the earth and sky, exclusive of solar irradiation. Between sea level and 45,000 ft, direct solar irradiation on the enclosure varies from 150 to 450 Btu per hr per sq ft of enclosure

area. This unit quantity of heat flowing through a fighter enclosure with an area 25 sq ft tends alone to increase the temperature of the approximately 50 cu ft of space in the cockpit by from 10 to 25 F.

The electric-heat component of the cooling load is usually negligible in fighter aircraft. However, if much electronic equipment is carried, the electric-heat component may be an appreciable portion of the total.

Body heat is also negligible in a single-place airplane, but in an airplane such as a large troop transport, it must be included in a careful analysis.

The sensible heat in the ventilating air is the product of the weight flow rate, specific heat, and temperature rise.

A TYPICAL COOLING PROBLEM

The sum total of the skin, solar, electric, body, and ventilating-air heat constitutes the cooling load and has a maximum value when the airplane is flying at maximum speed at sea level on a hot summer day. For purposes of computation, a temperature of 90 F is used for a hot summer day. For a typical jet fighter, traveling at 600 mph, the total cooling load would be about 7200 Btu per hr, exclusive of the sensible heat in the ventilating air.

We must get rid of this heat by some form of cooling, and it cannot be done by simple ventilation as is possible in slow-speed airplanes and in some buildings. This may be demonstrated as follows: If 90 F outside summer air is inducted into the ventilating system of an airplane traveling at 600 mph, its temperature immediately jumps to about 144 F, due to kinetic or aerodynamic heating. This means that the air which we have available for sweeping 7200 Btu per hr of heat out of the cockpit is already at 144 F. Obviously, the cockpit temperature can never be less than 144 F under the assumed conditions, and the actual equilibrium temperature which it will ultimately attain under the conditions depends upon the quantity of air which is passed through the cockpit. Even with a flow of 50 lb per min (which is a prohibitive quantity for a jet fighter), the final cockpit temperature becomes 154 F. This is physically unendurable except for a few minutes. Hence cooling of high-speed aircraft by simple ventilation is impossible. Moreover, conventional mechanical forms of refrigeration, such as the various absorption and compression systems, are also ruled out because of excess weight.

The system commonly in use is the so-called "simple system" of air-cycle refrigeration. Let us briefly trace the air flow through such a system. Starting with the outside air at 90 F on an assumed summer day at sea-level altitude, this air temperature increases to 144 at the inlet to the compressor of the airplanes jet engine, due to kinetic heating, and its pressure increases by 50 per cent, as a result of the ram effect. Upon emerging from the last stage of the engine compressor, its temperature exceeds 350 F, and its pressure exceeds 60 psi.

In order to cool the cockpit with this air, obviously, we must reduce this temperature considerably. This is done in two steps: (1) The air is passed through an air-cooled heat exchanger and (2) it is caused to drive an air turbine. The air turbine directly drives a disk fan which circulates outside ambient air through the heat exchanger. The exchanger removes about 90 per cent of the total heat existing in the air at its entrance. The turbine removes an additional amount, so that the final temperature of the air discharged from the turbine may be as low as —20 F. It has been found that a total flow of approximately 10 lb of air per min through such a system is adequate for cooling the single-place cockpit of a subsonic airplane under the worst conditions; namely, sea-level flight at maximum speed on a cloudless summer day.

Control of cockpit temperature is by means of a thermostat relay-controlled motorized valve, which mixes cooled and uncooled air in the proper proportions to maintain the desired temperature. In a single-place cockpit, this same valve shuts off the cold air and admits the hot air from the compressor outlet directly into the cockpit when maximum heating is desired.

CONTROLS AND INSTRUMENTATION

The full implications of high-speed high-altitude flight have not been too well established and cannot be established until further experience is obtained by flight-testing with flying laboratories such as the Navy D-558. As we approach the rocket era, we find the factor of pilot adequacy becoming increasingly critical, for modern airplanes are fast outgrowing the ability of human pilots to control them, and the general trend in airplane design and performance requirements has resulted and continues to result in placing the pilot in an extremely and increasingly difficult position. High-speed aircraft control forces must be reduced to a value which will permit physical human control of the airplane concurrent with minimum fatigue on the pilot. One promising approach to the solution of this problem is the development of power-boost and power-operated control systems. Automatic control devices to control the airplane and its various components are becoming increasingly important.

Closely associated with the control of the airplane is the problem of instrumentation. One of the major problems is to determine whether existing instruments are adequate for speeds approaching the speed of sound, or whether entirely new types of instruments will have to be developed. The wartime development of an impressive list of electronic devices for automatic gun-sighting and bomb-laying, for communication, for navigation, for vision by radar, and for automatic piloting scarcely laid the foundation for the development programs we picture as necessary in the field of instrumentation. We expect that accelerometers, angle-of-attack indicators, and Mach meters, all of which require further development, will play an increasingly important role in high-speed flight.

Methods of indication are also expected to change through combinations of instruments and the development of counter-type indicators to lessen the work and interpretation required of the pilot.

Aircraft instruments no longer consist of simple gages mounted on a panel. Instruments, including the required navigation equipment, are evolving of necessity, from gages to systems and from indicators to controllers. Far beyond the simpler aids of the past, the object of the new automatism is to supplement and, in some cases, even to replace human judgment and response, in order that the airplane may be directed by simple over-all commands, thus permitting safe flight which, otherwise, would be beyond the capabilities of human pilots because of the distortion in space and time which is created by high-altitude high-speed flight.

CONCLUSION

The foregoing is just a glimpse of some of the problems which the transition from conventional to high-altitude high-speed flight has brought to the designer. The work of all of us connected with the aviation field involves an attack on many frontiers heretofore not explored. While the problems ahead are extremely difficult, costly, and time-consuming, the author is confident that they will be solved by the team which has been responsible for our past success; namely, the aviation industry, the scientific world, and military aviation.

The STATUS *of* TECHNOLOGY
as Related to the Questions of Today

By KARL HOLEY

PROFESSOR OF ARCHITECTURE, TECHNISCHE HOCHSCHULE WIEN

OUR times are replete with questions and tensions; questions which press for answers and tensions which demand relief. Our epoch is accepted as one of technology. Of particular interest is the position, with respect to the questions and tensions which fill our world, that is expected of that technology, which has made so much seemingly impossible, possible, which has so often been turned to for help in time of need, and which has been made responsible for all evil in the world and damned therefor.

This expectation leads us into the realm of metaphysics of technology, into that science beyond the physical, beyond that perceivable by the senses, into the realm of the supernatural, superempirical, transcendentalism of Technology.

Does the power of Technology really go so far?

Everyone will admit the sheer immeasurable power of Technology as it pertains to its influence on the external course of human existence and natural events. There is scarcely a dream wish of humanity which has not been filled by Technology. Time and space are overcome. The might of Technology not only prevades our planet but stretches far out into the universe. Slumbering forces in nature have been aroused to an unsuspected and unimaginable degree and are subject to the service of Man.

The external means of power which Technology has given Man mounts into the immeasurable. In this realm of nature there is scarcely any question which Technology cannot answer. There is no tension which it cannot relax.

In this sense, the words of the great Greek poet, Sophocles, are pertinent, "There are many natural forces on earth, but none greater than Man."

When we conceive of Technology in this way, we mean the command of appropriate means in order to attain a sought-for end in the external world. This is a biased concept. The disproportionate values placed on material performance go so far that the word Technology entirely loses its inner spiritual meaning and is thought of as representing an especially great ability to perform material tasks. This does not exhaust the essence of Technology.

The true sense of Technology lies deeper, otherwise one could not speak of the Age of Technology. The term Age of Technology is valid not only for our times. Prehistoric and early historic periods bear designations consistent with the technological characteristices of the period, such as the Stone Age, the Bronze Age, and the Iron Age.

What can this mean other than that the materials of Technology and their processing were considered of utmost importance and found expression in the naming of periods covering several thousands of years of time.

We can go still further and do not go too far when we say that each age and indeed the whole span of human existence is a function of Technology.

Keynote address delivered at the Centenary Celebration of the Austrian Society of Engineers and Architects, Vienna, Austria, June 3–7, 1948, translated by Col. T. A. Weyher, GSC, Assistant Military Attache, American Legation, Berne, Switzerland. Mem. ASME.

What does the word Technology really mean in its original Grecian significance but active creation and creative activity, the mastery of the purely material by powers commanded and directed by the human mind? The creative mind created by Technology a new realm beside and over that of Nature, a realm which was previously nonexistent in the visible world, a realm which had existed only in the invisible realm of ideas and is now a living reality.

As Man in his life is bound to and dependent on the surrounding world, so is he likewise closely bound to this new natural realm which he created through Technology. One is tempted to use the divine word of creation with respect to the might of Technology, "et tu renovabis faciem terrae."

But Technology not only renews the features of the earth but fills the inner being with new spirit. One could say it is not philosophy which provides the basis for intellectual growth, but rather Technology, bold as it may sound.

If we let those considerations pass as valid, I would like to attempt to bring out a few examples from the history of development of human culture.

We speak of whole ages that were named after Technology and have mentioned the Stone Age in that connection. A masterful picture of that era stands before us in the powerful assembly of structures in Egypt which belongs to that Age. One can name the state, which for thousands of years gave direction to the spiritual development of man, the State of Stone. The external stuff, the material from which this monumental picture is built, is stone, hardest stone, timeless, intended for eternity. At no time in the history of ancient peoples did the thought of Eternity play so great a role as in Egypt. The miracles of the building art, whose Technology evokes from us even today the greatest astonishment, are dedicated to Eternity, the external, unapproachable gods. Everything is for the service of Eternity. Man is small and pitiful compared to those works he himself has created; he must subordinate himself into humiliating nothingness before the great thoughts of Eternity which his Technology and Art pronounce forever and everywhere.

Man's own power in Technology appeared so great to him that he felt himself one with the divine creative will. He compared the masters who had created these works with the gods. We know that the temple master Imhotep, builder of the Pyramids of Sakkara, who lived 4000 B.C., was worshipped as a god.

Howsoever strongly put together the state organization and howsoever great the power of its rulers may have been, all that was only a symbol of the one all-mastering thought of Eternity. Everything which happened in this world was only a preparatory step to Eternity, and everything which occurred in the Eternal Life was only a continuation of life in this world. An inseparable interweaving of the transient with the permanent so that there was nothing really transient, this unbounded power of thought, of the mind, was proclaimed by the Technology of the Egyptians.

ROMAN TECHNOLOGY DEVOTED TO SERVICE OF MAN

The Technology of the Romans was of an entirely different kind; it was derived from the mastery of the world and was directed to the service of man. The techniques of road building, of hydraulic construction, and bridge erection, made it possible to extend the sphere of influence further than was formerly possible. Technology gave man the ability to make his life as pleasant as possible. Communications technique gave commerce the possibility of acquiring the wealth which produced for Man all the joys and pleasures of good living. Next to the temples of the gods were found the hot baths, the theaters, market places, stadiums, and dispositions for Circean plays. Technology made the Romans masters of life in this world; first life, then philosophy. And Philosophy with its system followed the way prepared by Technology. The anthropocentric rationalistic philosophy which considers man and his reason at the center of everything is a consequence of this development of Technology which has made man the master of his existence.

FLOWERING OF THE SPIRIT IN THE MIDDLE AGES

We encounter a new essential characteristic of Technology in the Middle Ages. It is the contrast of Christian to heathenist Technology, the contrast of spiritual to material conceptions. A single example will serve to make this clear, the Gothic arch technique, the art of buttresses and arches. The Romans as well as the Egyptians and the peoples of Mesopotamia knew how to build arches, but the Gothic style was a change in the innermost essence and spirit of the arch. The arch of the Romans was primarily massive, the plane was predominant. Forces were bound, they slumbered in matter. The Gothic arch wakened the working of force. The action lines of the arch ribs came into being and found their partners in the lines of the buttresses. The Individual emerged from low heavy masses. Quiescent matter became living action and struggle. The Spirit which was already imminent in the mass, was awakened to an independent free life and overcame matter. Matter received a soul, the individual came to life, and life meant struggle. The struggles of the knightly lords among themselves and against the rulers of the land, the dissension between churchly and worldly rulers, the growth of the individual classes and their struggles toward independence, all that is symbolically contained in the Technology of the Middle Ages. As, in spite of the struggling action of forces, the fairylike marvels of the Middle Age cathedrals reach into the heights from the depths of this life, so the unifying thought of service to the Almighty stands above all combat and strife. The mind is ever the victor over matter. This thought also characterizes Christian philosophy of the Middle Ages. Strange as it may sound, mysticism and scholasticism are closely bound to the spirit of Middle Age Technology. Technology is just not to be considered with materialism alone.

ANTICIPATION OF THE MACHINE AGE IN THE RENAISSANCE

In the Renaissance, the influence of Technology on the period and the urgent questions of the times continually grew. Technology was not yet dominant in the realities of the day, but the leading men of action of the Renaissance dreamed of the sovereignty of Technology in a Machine Age. Indeed, such a phantasy had already been born among the ancients. As Aristotle once said, "If each work tool could perform work assigned to it on command or even in anticipation of a command such as the automatic creation of Daedalus, or the crucible of Hephaestus which set about its divine work under its own power, or if the loom's shuttle moved back and forth through warp and woof by itself, or the Zither's mallet should strike the right string by itself, the hand of man would be unnecessary to execute any art. The master builder would need no carpenters or handymen, the master mechanic no helper, and the master and family no slaves."

When the water wheel was invented and used to drive millstones for grinding grain it was hailed by a poet in Cicero's time as the emancipator of slaves and the creator of a golden age.

Those dreams of the ancients were not based on beliefs in the life beyond as were those stemming from the spirituality of the Middle Ages which desired no dominance over the external phenomena of Nature. But the man of the Renaissance who wished to restore the ingenuity of the Romans needed first a Technology which would give him mastery over the phenomena of this world. His reason would give him the might, and the newly found knowledge of natural sciences would help him achieve mastery over Nature. This demand was expressed to an exceedingly great degree by the life, thoughts, and works of that universal genius who gave the Renaissance its character, Leonardo da Vinci. A keen observer of Nature, gifted with a powerful imagination and with a soul full of the urge to create, all his thoughts and actions were filled with the desire for an Age of Technology. He sought to penetrate the secrets of Nature's forces; he studied natural phenomena; he investigated the action of forces, and continued the thought of the intellectual spiritual Technology of the Middle Ages. He held mechanics for his Paradise. In investigations of statics and kinetics, he went far beyond his predecessors and contemporaries. He succeeded in recognizing many truths which were generally accepted only in later centuries. He wrote nine books on hydraulic construction with projects for pumps, waterpower machinery, diving apparatus, and submarines, on tunnel building, and on aircraft based on precise observations of the flight of birds. He filled many pages with drawings and designs. Even the idea of an airscrew, forerunner of the propeller, occurred to him.

With Leonardo da Vinci, as already mentioned, a fundamental characteristic of technical thinking was particularly strongly expressed, the power of imagination. Dagobert Frey saw in the development of the capacity to imagine in the Middle Ages, a foundation for the spiritual maintenance of this age. Essential to the thinking of the engineer is the strength of his capacity for imagination.

The creative artist and engineer Leonardo da Vinci, was not the only one busied with thoughts of a machine technology. Another great mind which lived a century later, Sir Francis Bacon, the founder of empirical natural science, saw in the recognition of the properties of Nature the means of making Nature serviceable to the well being of man. In his novel, "New Atlantis," which appeared in 1624, the inhabitants of an island realm of the same name led lives of complete earthly bliss. The islanders were in possession of most of the achievements which were bestowed on mankind only in our own times. They had heat and hydraulic engines, understood how to use the forces of the universe, the sun and the wind, built towers 800 meters high, and penetrated deep in the earth's interior. They possessed the art of television and radio, airplanes and submarines, knew the laws of meteorology and could influence natural phenomena. They understood how to recognize incipient diseases and how to cure them. In short, they had everything necessary to a happy life on this earth and were thereby filled with a deeper Christian religion. The publisher of this novel, Bacon's secretary, Chaplain Rawley, remarked in the preface that this wonderful dream picture would probably never be entirely attained and added, "But mankind need not despair that it will one time attain this goal in its essentials by persistent effort."

From these few examples, which can easily be multiplied, it is distinctly seen how greatly this period is filled with the spirit of Technology. Many of the great philosophers of this period and of the following century such as Galileo, the physicist; Descartes, the founder of analytical geometry; Leibnitz, the creator of differential calculus; and even Kant, stand within the confines of that natural science, the mathematical direction of Technology.

One may say of Kant that he created the first fundamentals of the philosophy of technology in his third principal work, entitled, "Kritik der Urteilskraft" ("Critique of Judgment"). One could also call this "Critique of Technical Reasoning." Kant says, "To arrive at the correct decision in a legal dispute is in no way a matter of intelligence alone. A Jurist can have the clearest view over the whole legal field and yet be unable to arrive at the correct decision in a given case. He needs, in addition, a talent which must be inborn. The wisdom of the people calls this gift common sense. It cannot be explained. The power of judgment is the basis of the specific human ability to hold to appropriate courses of thought or action." In the following statements Kant unknowingly made the attempt to incorporate Technology in his ideas of the cosmic position of Man.

THE TECHNOLOGY OF TODAY

In the eighteenth century, the yearned-for Machine Age really arrived. Its first dominant inventions were made in England. About 1700, Newcomen created a source of power not bound to any place in his atmospheric piston engine or so-called "fire machine" which soon had many uses. I remember in that connection such a fire machine built by the son of our great baroque architect, Johann Bernhard Fischer von Erlachen, Joseph Emanuel, and installed in Schwarzenberg Park for the supply of water.

The invention of the steam engine by James Watt in 1765 had far-reaching and determinative results through which industrialization and the whole transportation system were directed into new paths. Inventions in the field of chemistry and electricity led to a new form of Technology, the utilitarian Technology, the Technology of today. It is well known that the social organism, the social structure of the last two centuries, has become a function of the development of Technology. The labor question in all its forms and effects is a consequence of the appearance of Technology. Capitalism and Socialism cannot be explained without Technology. In place of individual groups of families, dynasties, or classes, the impersonal greatness of capital as the symbolic expression of potential energy steps in. The old organic forms of society were dissolved by the superindividual mechanical organization of the masses. The thought methods of physical-mechanical Technology and Natural Science are carried over into the ethical-social areas. The world is interpreted as a high machine, as automaton, and this significance was surmised by the philosophy of the seventeenth century.

The surprising successes of Technology in the eighteenth century which seemed to show Man how Reason, to which Technology was ascribed, delivered into his hands, by technological inventions, strong means of power, supplied the impetus leading to the origin of rationalism and the enlightenment which further led to Liberalism in the classical period of Machine Technology. The citizenry are brought by Machine Technology to well-being, and the unfolding of the individual demands free space for the action and influence of that individual. The knowledge of the power of the individual is growing and leads to the refusal of all restraint. The more free the individual, the greater the progress in economic and social life.

The gigantic extent of later developments of Technology leads to a mass Technology and to the organization of the masses against dehumanization against which socialism fights.

The opposition of the worker to the machine existed at the beginning of the Machine Age in England. The opposition became stronger and stronger with further development of the "Occidental Idol," as Ghandi called the Machine.

MISSION OF TECHNOLOGY TODAY

It will be the mission of Technology in our age to replace the materialistic concept of Technology with an idealistic concept and to show what high moral values lie in Technology. The overestimation of reason must be decreased by the recognition that the essential element of Technology is the power to create, the godly work which lifts man from the misery of materialism. Technical work which becomes an entity from the assembly of parts only through the co-operation of many will strengthen the feeling of everyone of belonging together as being of ethical importance. The deep feeling of responsibility which is found in a technical creation, is a valuable idealistic characteristic of Technology.

Technology enters a new age. The empire of external things whose creation proceeds so quickly that no time is left to reflect on the deeper sense of this new realm, will receive its complement in the way of a spiritual kingdom of Technology. Thus a true Age of Technology is originated. We shall recognize that the cause of misery and want in our time lies not in Technology but rather in us ourselves. We have forgotten the moral empire for the material empire. We must penetrate to the eternal values of the creative spirit and the position of Technology with respect to the questions of the times will not be pessimistic but rather heroic and optimistic.

Evaluation of Reynolds Number by Graphical Methods

(*Continued from page 876*)

number. A similar chart could be made on which the kinematic viscosity would be read in stokes or any trade units commonly in use.

A solution for N_R in the form of a nomograph is presented in Fig. 2. A straight line, joining values for the velocity and pipe diameter, intersects a third axis midway between these points, yielding the product VD, which is undesignated in the figure. A second straight line, joining this mid-point of intersection with the kinematic viscosity of the fluid, will cross the axis for Reynolds number at the point representing the value of Reynolds number for the given flow.

In some respects the use of the nomograph possesses advantages not offered by Fig. 1. With the nomograph, the names of the fluids can be arranged directly along the ν-axis, eliminating, in many cases, the use of a separate table for the numerical values of the kinematic viscosity. Other advantages also appear. For instance, the conversion from one system of viscosity measurement to any other can easily be made by showing both scales on the same axis. On the other hand, comparing both charts, it can be seen that on the nomograph the scale for N_R is only one fourth as long as the scale for the velocity; whereas in Fig. 1 these scales are of the same order, lending a determination of N_R with Fig. 1 four times as accurate as given by the nomograph. Other differences appear in the way of size of chart, range of scales, and ease in reading. The use of one form in preference to the other depends largely upon particular application.

AMERICAN INDUSTRIES *Built Upon* ENGINEERING *and* SCIENCE CAN SAVE *the* WORLD

By E. G. BAILEY

PRESIDENT, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

IT is high time to clear the record and to give straight engineering facts about American industry. There seems to be no better place or time to do this than now at this meeting in the City of Philadelphia, where the instrument manufacturers are exhibiting their products and presenting papers to help American industries and the world to further vitalize their production processes to attain more goods and services with a minimum of man-hours of effort.

THE INDUSTRIAL-INSTRUMENT INDUSTRY

The industrial-instrument industry in the United States is relatively small, for it includes only that class of equipment applicable to the chemical, metallurgical, mechanical, and power processes of other industries. There are about 140 manufacturers exhibiting their products at this meeting.

Their gross annual sales in this field amount to probably less than $250,000,000. They are typically American companies, most of which started on a shoestring, wherein someone invented a temperature recorder, a flowmeter or some such useful device, which when perfected and sold to other industries aided them in saving fuel, producing better chemical product, reducing labor, and protecting life and property.

Some of these instruments only guide an operator responsible for an industrial process so that he maintains conditions satisfactory for high quality and maximum output of a product. Many of the instruments are connected to automatic equipment, thereby completely controlling a process and assuring maximum economy in production, with only general supervision by man.

Our instruments and regulators are the guiding nerve center of every large power-generating system in this country. Regardless of whether the source of energy is coal, oil, gas, or waste fuel, our equipment guides the proportioning of fuel and air for best combustion, which is the very essence of our ability to relieve mankind, through the use of tools and power, from the toils and slavery of the past. Complete electrical generating units as large as 200,000 hp are operated continuously for an entire year, burning 400,000 tons of coal without shutdown or need for a fireman to use a shovel or slice bar. The instruments operating this unit take ample care of variations in load demand smoothly, without the equivalent upsets such as we often have had in our economic cycles of prosperity and depression.

A relatively small investment in instruments and regulators is guiding the generation of several billion dollars' worth of power each year. The production of many billion dollars' worth of chemicals, rubber, petroleum, iron, steel, and other products is being aided with respect to quality and output through the use of instruments.

An address delivered at the ASME Luncheon of the National Instrument Conference, September 14, 1948, at Philadelphia, Pa.

AMERICAN INDUSTRIES ARE THE SERVANTS OF THE PEOPLE

The instrument industry is in a peculiarly strategic position to really know a great deal about many other industries because its equipment is applied at the very heart of their production. Instruments and regulators are not just sold off the shelf and installed by the customer; their application to a process is worked out between our engineers and those of the customer, practically tailor-made. When placed in operation the equipment is serviced to the degree necessary to obtain the desired results, in which industry's top executive management is keenly interested.

It is obvious that some of us who have had such entree to American industry over a period of nearly fifty years, can speak with some knowledge about the inner motives and accomplishments of the people who really run our industries, as well as many of the workers in their plants with whom we come in day-to-day contact. From such experience we know that the great majority of companies composing American industry are sincerely and honestly serving their customers—the American people. Most of them are treating their employees more fairly than some employees are responding with zealous interest and effective work for the pay they receive and the opportunities open to them for advancement.

INDUSTRY IS BASED MORE ON ENGINEERING THAN ON FINANCE

Industry is a group of people co-operating through the use of tools, equipment, and methods to produce goods or services from natural resources for the needs or wishes of mankind.

This group of people, usually recognized as a company or corporation, includes engineers to invent and perfect the products to be sold. The product is the key to the company's existence. The raw materials (natural resources) must be acquired and manufactured by personnel, usually engineers, skilled mechanics, and workers to man the production machinery. The executives must look after finance, sales, and distribution of the product.

An individual company in industry is usually the image of the man or group of men who manage it. If so, then the creed for the success of the company should be the same as it should be for the individual person:

Keep healthy.
Acquire knowledge.
Be honest.
Help others.

The others whom the industry should help in order of obligation are (1) its customers, (2) its employees, (3) its stockholders, and (4) the community and the nation. If these things are all done in sincerity the company will prosper.

The all-important problem of keeping an industry healthy resolves into:

1 Make a product for which there is a demand.
2 Keep the quality of the product high.
3 Keep the selling costs low.
4 Render good service in the distribution of the product.

A considerable share of the responsibility for accomplishing these requirements rests with the engineering branch of the industry.

The top management has the complete responsibility for selecting and training competent men composing the organization, and maintaining co-operation between the departments for best judgment and incentive to keep the industry healthy and prosperous.

The history of most companies is that a new invention or an engineered product offers possibilities of usefulness if made and marketed. Usually a relatively small amount of financial aid is needed at the start. If the product is economically sound and the management sufficiently intelligent and industrious to keep the company healthy, its growth will build up values enough to take care of its normal expansion. The company with proper management and co-operative workers will create wealth for its own financing.

The only source of wealth is from man-hours of effective effort. Even natural resources are not wealth until they have been utilized through man's ability and work.

WHO MANAGES AMERICAN INDUSTRY?

The great majority of companies which compose American industry are effectively supplying mankind with tangible goods, such as agricultural products, automobiles, electric appliances, fuel, chemicals, textiles, and many kinds of tools and equipment for other manufacturers. They also supply such services as communications, power, transportation, and a wide variety of knowledge on many subjects.

These goods and services are supplied to us in volume and with such a reduction in man-hours of hard labor that many, it seems, are spoiled almost to the point that they do not want to work at all.

The latest data[1] give less than 30 million people working in industry (including agriculture) to supply our 140 million people, and in addition provide much to sell and give abroad.

Industry, if healthy, also donates, collectively, large sums for benevolences and education. It pays taxes and retains some of its earnings for reinvestment and extension of the business for the mutual benefit of employees, stockholders, and customers.

The ownership of American industry is very widely spread over millions of workers and masses of people. The actual management of the great majority of companies making up our industry, is in the hands of officers and personnel who have grown up with the industry. Like the roots of an oak tree, the true basic value of our industries resides in the organization of people who are seldom seen or heard by the general public.

The companies which fail to keep healthy are sometimes taken over by unscrupulous capitalists, with many headlines and much publicity for a very definite purpose, to the detriment of many. The nonthinking public or the publicity seeker may severely criticize all good and honest business, on the erroneous assumption that the few who may be under the control of such people are representative of all.

TO SAVE THE WORLD WE MUST FIRST SAVE OURSELVES

To save the world we should first improve our own status through further discovery of the laws of nature, through further use of science, and better solution of the engineering problems involved in making our natural resources available for the good uses of mankind.

In doing this we should not forget that all available forces are the gift of God for man's proper use. To complete our tasks we should see that all men better understand the problems, the aspirations, and the contributions which are to be made toward further education, invention, and above all, co-operative WORK.

As we approach a still higher plane of accomplishment—now believed to be possible—we can help the rest of the world emulate our methods for the good and peace of all mankind.

[1] "Road Maps of Industry," National Industrial Conference Board, no. 653, July 2, 1948.

AIR-CONDITIONING MASTER CRAFTSMAN

(Workman at Hartford, Conn., plant of Anemostat Corporation of America uses scriber, steel rule, and magnifying glass in his exacting work. He makes metal templets which will be used to check contours of aluminum cones used in assembling "aspirating" air diffusers needed for draftless air conditioning. Cones are spun in sizes ranging from 2 in. to 7 ft in diameter, and are mounted concentrically with respect to one another. Contour and spacing is of utmost importance because on it depends the ability of the unit to draw in 35 per cent of room air and mix it with supply air.)

The SUPERVISOR'S PLACE *in* MANAGEMENT

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WHAT IS MANAGEMENT?

MODERN management carries on under many difficulties. The free-buying customer is the real boss; the investor wants and deserves a return on his investment, which can come only from profits; Government is taking an increasingly important part in writing and rewriting the rules of business; the general public is being coached from all sides on what to expect from management; the employee wants freedom of action and security—not either, but both. Management lies awake nights, at no overtime, and tries to find answers to please them all.

The term "management" is difficult to define. It is a much used word, now appearing in many places, as the interest of the general public is increasing in the behavior of our industrial organizations. Management in actual practice, as well as in the imagination of the general reader, is about as variable as family life where the parents may be considered managers, or any other project which brings people together to accomplish a task. About the only common factor in various managements is the existence of different degrees or levels of authority and responsibility.

Many people have a conception of management as a sort of central "holy of holies." To them management is impersonal, it is more a "place" than "people," it is an authority, a weigher of evidence, a holder of responsibility, a designer of plans. In this picture of management, those between this small decisive group and the employees or workmen might be considered as "arms" or "mouths" of management.

One of the most common terms used in discussing industrial organization is "top management." What is the mental picture conjured up by these two words, top management? If there is a *top* management, then there must be *bottom* management. Couple this with the commonly used phrase, "ladder of success," and the picture is completed of management people in an organization all climbing a ladder. All the way up the ladder are people clutching at the bootstraps of those above them, all except the man at the top—he can go no further. Remember, we all largely think with pictures not words. Is that the kind of picture we want to make in the minds of employees or the public in general when talking of management?

Let's see what happens when we turn this ladder through 90 degrees to a horizontal plane. Now we look at management as an "area," everyone standing on the same level. At the center of the area we have "general management," extending outward we have "central" and "specialized management." Near the edge of this management area are the men who work directly with the employee, the "first-line manager," whom we in this paper will call the "supervisor." He is in that section furthest from general management, most recently appointed to his job, and closest to the thinking and actions of the employees in the enterprise.

Abstract of an address presented at the Fall Meeting, Portland, Ore., September 7–9, 1948, of The American Society of Mechanical Engineers.

In this area picture of management, it is possible to move from one management group to the other without going over people's heads—various routes may be established. Here is a great correlated team, each section with its special duties, yet everyone sharing, in addition, a common responsibility and authority, a common concern for the welfare and improvement of the entire organization. In this type of management, great effort is devoted to making sure that reasons for action are clearly given. The opinions of all members of the team are sought, listened to, and respected. This type of management may not operate with great speed, but it has the advantage of building that something into the organization which is of increasing if not vital importance to our modern industrial organization—the teamwork which spells continued low-cost production. In fact, this is actually the way most of our business organizations really operate, in spite of the organization charts on the wall.

Another set of terms now being applied to various management responsibilities, within an organization, are "executive management" in place of general management, administrative management in place of central or specialized management, and operating management in place of first-line supervisor.

THE SUPERVISOR—AN INTERPRETER

It should be clear from what has been said that the supervisor *is* a part of management, so let's see just what part. Primarily, and perhaps most important, he is an "interpreter." He interprets the viewpoints of the employees and the problems arising in his section of the enterprise to those in the central or specialized areas of management. Of equal or greater importance is his acting as interpreter to the men in the shop of the actions, statements, and decisions made by the general management.

The job of interpreting is a difficult one. Disturbances in international relations are sometimes traced to poor translation from one language into another. In the same way in a company, the interpreter has a real job of translation, keeping the pictures clear by using words which are understandable. Most supervisors have graduated from a "doing" job, where productive skill, dependability, and attitude provided the principal measures of success, into a "talking" job, where success depends upon how effectively they can convey their ideas to others largely with the use of words.

MODIFYING CUSTOM

A second responsibility of the supervisor is to serve as a "modifier of custom." Most of the people who sit on the sidelines and look at management's jobs, not infrequently voicing high criticism, are quite unaware of the simple fact that, through a continuous process of promotion from within, yesterday's workman or employee is today's manager. However, this process has created, in our rapidly changing industrial picture, some difficult problems for the first-line supervisor. Members of the central or general management groups at times base decisions on their own firsthand supervisory experiences of the

past. Thus yesterday's experience may be used to answer today's problems. The modern supervisor is meeting a changing educational level, social viewpoint, and governmental philosophy out where the impacts of the newspapers, magazines, and radio are constantly at work. Many shop practices are based on custom. The supervisor must modify these established customs or use his experiences to obtain changes in procedure.

RESULTS THROUGH PEOPLE—DEVELOPING UNDERSTANDING

The job of the supervisor is to get things done, to get out production in proper quality and quantity, at the lowest possible expenditure of materials and hours of work. This of course, calls for knowledge of methods, processes, materials, and the like. He must get these results, however, through people—people who are independent in thought and action—people free to come and, as we have all experienced in recent years, just as free to go. (And may it ever be that way.) So our supervisor's job boils down largely to solving all kinds of problems, but problems in nearly every case involving people.

Another conception of general management's responsibility is that of creating an organism which does the right thing spontaneously. Such a management group anticipates problems, avoids friction and clashes, uses prevention rather than cure. This calls for foresightedness rather than a sort of fire-department style of solving problems at the moment.

Regardless of how many or how big may be the books of company practices and policies supplied to him by his supervisors, he finds that to solve his everyday problems he must depend upon two things, (1) his ability to deal with people, to size up situations quickly and fairly, to decide the right answer in terms of the employee and the company, and give this answer; and (2) the *manner* in which he receives help from those in other areas in management. Here is one of the most important phases of management at work. Note that I stress the "manner" in which the supervisor gets this help, not the mere fact that he can get help. This help can be given in an understanding and noncritical manner, or the supervisor can be made to feel that he should have known exactly how to deal with the situation, and that his standing as a supervisor is lessened considerably because he brought up the matter. Nothing will more quickly shut off a supervisor's enthusiasm for his work or desire to reach out and help carry more of the management load than blunt criticism over some minor detail in his handling of a problem.

How well the supervisor manages his own job, without recourse to others, develops respect for and confidence in him on the part of the employees he directs. How well others, more experienced in management, work with him when he receives their help, develops in the supervisor self-confidence, a feeling of belonging, and the joy of understanding team spirit, which, by the way, is the very lifeblood of continuous efficient production. These two forces working together will go a long way toward further strengthening, in our industrial institutions, the constructive attitude toward the job, the feeling that all is well, the atmosphere of friendliness, "The Smiling Factory."

Many of the managers of American enterprises have been using different ways and means of transmitting to their employees not only a better understanding of the place of the "investor" and the "customer" but also a better knowledge of what might be called the facts of industrial life; for example, the reason why profits are essential to maintaining a healthy plant and secure jobs for the employees. Recourse has been made to newspaper advertising, radio, letters to employees, and the like, all with some effectiveness. However, the personal contacts between the supervisor and those with whom he works every day is the best place to develop a real understanding of the services of our modern free-enterprise system. A supervisor needs not only this knowledge, and the ability to interpret it effectively and clearly, but he must also have that helping hand on the shoulder from the areas of general management, encouraging him in this difficult job of interpreting. He will likely make mistakes; he will have to come back for new answers, but never discourage him in his efforts. He is in the front line of this battle for understanding.

The supervisor also is responsible largely for establishing opinions concerning his company in his community. If he is properly informed and desires to do so, he is always on the alert to give the reasons for any certain company action or announced decision. On the other hand, an uninformed supervisor or one who doesn't care, can in just a few words tend to add to the growing criticism of private ownership. All he has to say when asked a question regarding some new company practice is, "Why ask me, I just work there."

TRAINING—INFLUENCING POLICIES

To help the supervisor meet his problems properly most companies now have established various kinds and types of training programs where he is given every opportunity to learn the reasons for the way things are done and how the company operates in all of its various activities. Provided with this information, a capable supervisor is better prepared to meet most of these situations which arise in his daily work and in his contacts with his neighbors.

Occasionally, when discussing the place of the supervisor in management, some writers have painted a rather gloomy picture, have called him the forgotten man of industry, one, who, having left the protected fold of the employee, cannot return. Let's take a new look at this situation. The U.S.A. has been called the land of opportunity, where men of demonstrated ability may advance regardless of how humble their beginnings. When selected to fill this position of challenging responsibilities, the new supervisor is getting his chance to advance, to show what he can do, to prove himself. True, some of these new supervisors are unhappy with their responsibilities which cannot be left in the plant when the whistle blows. It is to the everlasting credit of our American industrial system that not only are men selected from the ranks to fill these jobs but that so few fail.

Labor laws have tended to focus the spotlight on the place of the supervisor in management. Some claim he has no voice in policy formation and therefore he is not management. At the same time, his actions have been considered the actions of management, and his company is responsible for them. A part of this problem is due to nonuniform terminology in referring to different degrees or areas of management as used by various companies. Regardless, however, of the name applied to a man on the management fringe—the freshman of the class, so to speak—while he may not initiate a statement of policy, his thinking and opinions certainly influence the ultimate policy. The supervisor talks things over with the member of management to whom he reports, and the process continues through the various relay stations to general management. The fact that these opinions pass through various hands cause some to feel that the supervisor has little place in the picture.

The greater the interest of the supervisor in the general well-being of the company, the greater his knowledge of company affairs, the greater his feeling of responsibility and his awareness of authority, the more accurate and complete will be his day-by-day reporting of what the man in the shop is thinking and saying. American industry will not be able to develop on the part of the public a real understanding of how it serves the common well-being of everyone until the first-line supervisor is generally equipped to serve effectively as a responsible and articulate member of management.

The EDUCATION *of the* ENGINEER

Gaps Between the Statement and Achievement of Objectives

By HARRY S. ROGERS

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THE aim of engineering education, broadly speaking, is to prepare men for entrance into the engineering profession. The purpose of the engineering profession, in turn, is to control the forces and to utilize the materials of the physical universe in order to satisfy the needs and wants of mankind. To prepare men for such broad purpose obviously involves education for group effort and community living, orientation in distinctive professional ideals, and discipline in attitudes toward and habits of work, as well as intellectual objectives in the scientific-technological area.

Specific intellectual objectives are, of course, more directly expressed in the context and methods of educational practices than some of the personal objectives. They include a mastery of theory, understanding of the methods of application, and knowledge of practical standards and procedures, together with the complementary power and skill effectively to use such knowledge for the solution of practical problems. They may be examined critically as the tools and methods of scientific-technological thought.

Engineering education has always been characterized by discipline in attitudes toward and habits of work such as accuracy, thoroughness, neatness, promptitude, efficiency, diligence, and dependability. Sound attitudes toward and high standards of work are probably as well achieved in engineering as in any form of education.

In an indirect manner the attitudes toward people and toward life and a sense of professional responsibility are also incorporated in engineering education. Some of these attitudes and values have been codified by the national societies, the State Boards of Engineering Examiners, and the Engineers' Council for Professional Development. These codes and canons present the specific and pervasive ideals of the engineering profession.

The objectives of engineering education have been so thoughtfully presented in the reports of the Society for the Promotion of Engineering Education Committees on Aims and Scopes of Engineering Curricula, in 1940, and on Engineering Education After the War, in 1944, that they need not here be elaborated in any comprehensive detail. If the avenues and means of their achievements were clear and convincing in all particulars, we might well be proud of our anticipated progress. Any such assumption is far, however, from the realities of the situation, for there remain great gaps between the statement of objectives and their achievement in educational practice.

For the examination of these gaps it is well to approach the goals of engineering education through that dichotomy introduced in the 1940 report of the Committee on Aims and Scopes, namely, scientific-technological studies on the one hand, and humanistic-social studies on the other. This classification parallels that of education into special and general so extensively elaborated in the report of the Harvard Committee. While very useful in describing the areas of knowledge, the borders of this division are transgressed when we begin to examine the nature of thought and the methods of learning and teaching. The classification is, nevertheless, useful for the purpose of exploring what the speaker considers the major problems in achieving the objectives of engineering education which have been expressed in the two reports of the SPEE committee.

Scientific-technological thought dealing with nature and her forces makes an effort to observe, to describe, to classify, to analyze, to explain, and to use constructively. It is objective, quantitative, and logical and is pursued in an atmosphere of neutral detachment. It may be applied in certain areas of humanistic-social studies as, for example, in the field of economics. Humanistic-social thought dealing with the moral, ethical, and political aspects of man and his institutions on the other hand, seeks to question situations, to phrase problems, to gather evidence, to weigh values, to make judgments, to direct conduct. It is subjective, qualitative, and seldom free from preconditioned emotional attitudes. Its pursuit in an atmosphere of neutral detachment is practically impossible. Conclusions in the former field are usually in the terms of truth or falsehood, while those in the latter are in terms of good or bad, right or wrong. The former deals with objective realities, the latter with subjective values. To admit this difference between the rational insight of scientific-technological thought and our insight into the value judgments of humanistic-social thought should not, however, lead us to the conclusion that values are wholly arbitrary.

The methods of scientific-technological thought can be contrasted with those of humanistic-social in still another way. In scientific-technological thought conclusions are accepted tentatively. We speak of principles and laws as truth with full realization of the fact that they are conditioned by the present state of knowledge. We utilize principles which we know to be inaccurate because they are currently the most useful tools available for the solution of practical problems. Knowledge is considered progressive and the current state approves and accepts, or corrects and amends, the earlier.

Contrariwise, it is impossible to say with assurance whether there has been advancement since the days of Greek philosophers in the value concepts of goodness and rightness. John Dewey says, "Socrates . . . deliberately strove to limit theoretical discussion to moral and political subjects. . . . His primary question was whether the various forms of social excellence, the virtues which commend recognition by others, can be taught, and if so, how. Consideration of this theme led him to consideration of the relationship of various virtues to one another and to their unity in understanding or rational insight. Since rational insight was found by him to be practically nonexistent among politicians, among the poets, who were the acknowledged moral teachers of the community, as well as among the sophists, his teaching came to its climax in a demand for the pursuit of understanding or wisdom." We are still struggling to find this rational insight in morals, ethics, and politics. It may be that the seeming futility of this struggle is one of the reasons for the displacement of philosophy in general education by the "social sciences."

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NATURE OF ENGINEERING THOUGHT

It will be useful to examine more specifically the nature of engineering knowledge and of engineering thought in its relationship to the achievement of stated objectives. "The evolution of engineering thought and of engineering practice has given us a body of knowledge based upon facts and principles that may be classified in five broad categories."[1]

1 Generic principles such as the basic concept of conservation of energy.

2 Basic assumptions (not always true but practically useful) which are made for the purpose of simplifying the mathematical analyses of physical phenomena.

3 Empiricisms, such as the properties of materials which have been observed and measured in the laboratory.

4 Derived principles, or working formulas which have been developed in various fields of practice.

5 Specifications and standards or codes of practice.

These principles, assumptions, standards, and practices are the working tools of the engineer. They are presented in courses which differ in their methods and emphases. Generic principles and basic assumptions are traditionally presented in fundamental courses directed primarily toward critical understanding. Such understanding of generic principles and basic assumptions rest primarily upon recognition of their underlying physical concepts. They are frequently so obscured by the presentations of textbooks and teachers that students accept them merely as statements or formulas to be remembered.

Empiricisms are best presented in the laboratory. Most of them have definite limitations within which they may be applied. It is very important that students understand the origin and limitations of empirical data and principles.

Derived principles and specifications and standards have evolved in the development of technology and of the arts of engineering practice. They are generally presented in applied courses leading to practical designs. While the emphasis in basic courses should be upon critical understanding, in applied courses emphasis should shift toward facility in the use of derived principles. It is most essential, however, that even here the student thoroughly understand the nature of the principles used and the origin and limitations of empirical data and standards of practice. In using formulas they should be required to identify the generic principles and basic assumptions or empiricisms from which they are derived.

In the long run, however, facility in the application of principles, either generic or derived, of empiricisms and of standards to the solution of new problems is based upon a critical understanding and a conscious recognition of these tools of engineering thought. No other one thing ties the engineering profession more closely together than this way of thinking.

THE PROBLEM OF ACHIEVEMENT

The greatest gap in the achievement of educational objectives stated by the Committee of the SPEE lies, however, in the lack, in both educational and professional groups, of a thorough critical understanding of this basic and generic philosophy of engineering thought. This lack results in a failure to integrate the training given in particular courses of a curriculum and to develop in students a general power of constructive engineering thought.

A forward step in the correction of this condition has been made by the statement of this philosophy in the 1944 report. It is still necessary for the great bulk of engineering teachers to achieve a critical understanding of this philosophy, to orient their teaching in recognition of these principles, and to become articulate in the generalization of engineering thought processes so that students may be led to a higher critical understanding of engineering science and may develop through such understanding a greater facility and power in its application.

In further bridging this gap it would seem that we can expect little direct help from the philosopher upon the nature of knowledge, or from the psychologist upon the methods of learning. While the scholarship of both has much to contribute to the understanding of engineering education, the failure of both to understand the particular nature of thought in the applied physical sciences makes it necessary for engineers themselves to initiate the effort to secure aid from these two fields. Progress in the development and acceptance of a unifying philosophy of engineering thought, nevertheless, may be reasonably expected.

OBJECTIVES OF GENERAL EDUCATION

Now on the other hand when we turn to the humanistic-social field we find entirely different conditions. It is not possible to separate the aims of this branch of engineering education from those of general education or the liberal-arts college. The distinguishing purpose of general education in contrast to technical education seems to be to control personal behavior and group effort in such a manner that men may co-operatively work out their lives in a complex and interdependent society. While certain of the methods of thought employed in the humanistic-social field are becoming increasingly scientific, the characteristic methods are, nevertheless, speculative, philosophical, and judicial.

When the engineer examines the fields of knowledge in general education, the nature of thought in morals and politics, and the methods of achieving value concepts, he is confronted with a confusing situation. During recent years there has been widespread discussion concerning the ends and means of general education. Many reports have been written upon it, and many appraisals have been made of it by scholarly authors. A review of these publications leaves one with the general impression that there is a consensus that something is wrong with general education. There is some normative accord among divergent ideas as to what is desired from general education in a free society, but there is great lack of agreement as to how accepted objectives may be attained.

In concurrence with this whole ferment of thought regarding general education, engineers too have become concerned about the course of democracy and their own civic and social responsibilities. They have outlined their broad objectives in humanistic-social studies in the report of the Committee of 1940. These broad aims, presented in abbreviated form, include such purposes as:

1 Understanding of the evolution of society.

2 Ability to make critical analyses in and arrive at intelligent opinions about social and economic problems.

3 Ability to organize thoughts logically and to express oneself lucidly and convincingly.

4 Acquaintance with some of the masterpieces of literature.

5 Development of moral, ethical and social concepts.

6 Attainment of interest and pleasure in these pursuits.

In the 1944 report these aims were reiterated and recommendations were made with regard to the conditions under which most effective progress might be made toward their attainment. The responsibilities and roles of citizenship were further outlined in some detail. The program and method of instruction for their attainment were, however, presented briefly without specific recommendation.

If engineers had a conclusive answer to the method of achieving such aims they would be in a position to advise the liberal

[1] The succeeding five paragraphs are quoted with slight changes from the 1944 report of the SPEE.

college on general education. Unfortunately, or better perhaps, fortunately, such is not the case. That engineers are skeptical of the methods and achievements of general education, however, needs little elaboration.

We have listened too long to such trite expressions as the "liberal arts prepare one for living, whereas specialized training prepares one for making a living." Somehow or other these statements made without factual evidence do not carry weight. It seems apparent that those who make them are confusing the cumulative contributions of liberal culture to mankind with achievements which can be reasonably expected from two years and eight months of general education. There are many data that might be presented regarding the validity or invalidity of such conclusions, but time will not permit of anything more than calling attention to the fact that in The Carnegie Foundation's "Study of the Relations of Secondary and Higher Education in Pennsylvania" the engineers made the highest score in the field of general culture. (This result may, of course, throw some doubt on the validity of the examination.)

It would take a large volume to present the view of engineers upon general education. And it is doubtful that accord would be found in their opinions on the solution of the perplexing problems of general education in molding personality and character. The speaker will therefore present certain personal views which may not be regarded as scholarly, but which nevertheless have a certain sense of validity in the examination of the gap between the statement and achievement of objectives in general education. Because the report of 1944 placed major emphasis upon the responsibilities of democratic citizenship, these remarks should be considered as particularly applicable to such objectives.

NEED FOR DISCRIMINATION BETWEEN KNOWLEDGE, FEELING, AND CONDUCT AND FOR DETERMINATION OF MORE SPECIFIC GOALS

It would seem that the failure to attain goals centers pretty largely about the failure to discriminate between the manners in which knowledge is acquired, in which feelings, emotions, attitudes, and beliefs are conditioned, and in which conduct, behavior, and action are channeled. It is not an unsurmountable task to give engineers a survey of the facts related to the evolution of western society. It is not difficult to teach them to make critical analyses in quantitative terms of problems involving social and economic elements. Some engineers can even be trained to organize thoughts logically and to express themselves clearly. The engineer readily understands and adopts the realism and rationalism which have been responsible for the development of the term "social sciences." When, however, we come to the study of the subjective aspects of the humanistic-social field and the appraisal of the values as differentiated from the weighing of quantitative facts, the engineer finds little guidance for responsible citizenship in the typical courses of general education.

Howard Mumford Jones, examining the titles of great works of literature used for general education, says: "The list, however, includes Plato, an apologist for the authoritarian state, Aquinas, an apologist for an authoritarian church, and Hobbes, an apologist for an authoritarian monarchy. It includes sceptics like Lucian, Montaigne, Swift, and Hume; it includes Pascal, who taught that man knows nothing and can know nothing by the unaided reason; it contains Malthus, Darwin, and Marx, who held that life is a ruthless struggle; it contains Hegel, the theoretical ancestor of Nazi Germany. You will not find in it the names of Thomas Jefferson, Ralph Waldo Emerson, Abraham Lincoln, Walt Whitman, or Mark Twain, whom I cite, not because they are Americans, but because they are believers in the common man."

It would seem that the pursuit of such studies would hardly lead to that unity in the sense of values and common standards which is demanded by democracy. Doubts must be raised concerning the influence of knowledge about these great works, upon the feelings, beliefs, and motives of embryo citizens. Has not the neutral detachment of the scientific observer been so far extended into the humanistic-social field as to frustrate the development of value judgments and their motivation in conduct? Does not our democratic society rest upon common beliefs and is not the perpetuation of these beliefs a major task of education? Are not these beliefs given orientation by our religious convictions and commitments?

If results are desired in terms of feelings, beliefs, conditioned attitudes, and behavior, should not the humanists, the political philosophers, and the moral teachers be asked to organize emotionally weighted concepts in a rational manner for the purpose of obtaining some measure of normative mental organization and unity of conviction and conduct in responsible citizenship?

Such questions are entirely too large and perplexing for the layman to answer, yet they point to the reasons for one of the greatest gaps between the statement and achievement of objectives in the humanistic-social field.

Of course, we like to think that knowledge about the facts of history, sociology, and economics may be so accurate and complete that sound moral and social beliefs will be the inevitable conclusions, but such is not the case. Within the scope of professional training, and perhaps within a program of general education, time does not permit the attainment of any high level of critical or philosophical understanding of the good man or good citizen. Many examples, furthermore, of immoral and unsocial conduct on the part of Nazis, Fascists, and Communists well informed in history, can be used to illustrate the gaps between knowledge, beliefs, and conduct. It is possible also to present many illustrations of emotionally conditioned and socially constructive feelings, beliefs, motives, and attitudes held with similar conviction by both those who do and do not possess scholarly knowledge in the humanistic-social field. There likewise seems to be slight correlation between the education and the behavior, conduct, and course of action as responsible citizens, of scholars, of professional men and of men of practical affairs.

To achieve results in the education of students for responsible citizenship in these emotional and volitional areas will require a more specific determination of the social and philosophical considerations of general education by competent philosophers as well as a more comprehensive and valid development of the theory of mental organization and the structure of personality on the part of psychologists.

OBSTACLES IN THE CONDITIONING OF AFFECTIVE NATURE

Among the obstacles confronting any such development are the current absence of interest in philosophy and the concentration upon testing and behavior in psychology. Furthermore, any effort to develop emotionally conditioned attitudes is beset by many pitfalls for such attitudes may be used as effectively for regimentation and demagoguery as for the development of worthy social motives and of responsible democratic citizenship. Perplexing and difficult as these problems may be, they must nevertheless be undertaken if we are ultimately to arrive at some unity of understanding of the good man in the modern social climate and to achieve results in the education of students for responsible citizenship.

It is conceivable that there may be strong opposition to departure from a position of neutral scientific detachment within the areas of general education, but should we fail to undertake the correlation of knowledge with the conditioning of attitudes and behavior we had better stop prating about preparation for responsible citizenship.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

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MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Engineer Administration Training

IN an article in *The Journal of the Engineers' Guild*, July, 1948, D. B. Hoseason points out that many engineers take on administrative responsibilities so gradually that the change in their activity is not always realized and they fail to equip themselves for their new responsibilities to the extent that they might do. There is no doubt but that administration calls for a broad liberal education and the concentrated work which the young engineer has to do in the scientific field frequently prevents him from giving the attention to philosophy and the arts which full administrative success usually needs.

According to Mr. Hoseason, the young engineer, therefore, of twenty-eight or thirty, who finds himself becoming an administrator, should take steps at self-education which, in the main, should widen his knowledge in the classical and arts spheres. There are certain fundamentals on which the whole structure of administration is built and these are usually to be found in the great essays, not only in Greek literature but in those of the present day. The student of administration should find time to examine the nature of Justice, as discussed in Plato's "Republic." He should study also the nature of Truth, principles of Liberty, and the development of such characteristics as courage, loyalty, initiative, co-operation. This program will inevitably lead him to read the works of John Stuart Mill, Herbert Spencer, Lord Morley, and others.

Apart from the examination of what have been called "the fundamentals of administration," the young manager should make a practice of reading literature which deals with the application of these fundamentals. He should study the biographies of some of the great administrators, such as Henry Ford, Andrew Carnegie, and General Montgomery, and in doing so should not rest satisfied with the facts of the careers of these men, but should attempt to analyze their characters and decide what it was that made them successful. He should also endeavor to decide whether a man like Andrew Carnegie would have been equally successful in the twentieth century or in some totally different industry. Other fields of literature will no doubt suggest themselves.

Probably the least important section of administrative knowledge, but one which cannot be ignored under modern conditions, is that which deals with the tools of administration such as mechanical costing, labor cost control, and aids to productive efficiency, aptitude testing in the formation of a team, market research in the development of sales, and so on. Books on these subjects are legion, but considerable discrimination is needed in the selection of authors who can be relied on to present their subjects without exaggerated importance, placing each technique in its proper relation to the general field of administration.

The young administrator also has a responsibility to his job in connection with the routine involved. Some examples of these are public speaking, report drafting, and the taking of the chair at a meeting. Chairmanship of gatherings is an important part of the administrator's equipment, and very few men are sufficiently gifted to be able to rely on their natural aptitude, without taking regular training in this field. Words are the principal tool of the administrator and a power over words is essential to handling a team effectively.

In general, the young engineer with an aptitude for leadership has all the necessary fundamental qualities for a successful career as an engineer administrator. He must, however, realize that his early success as an engineer probably owes much to the concentrated attention he has given to engineering matters and has resulted in a corresponding lack of knowledge on administrative subjects. Although some self-congratulation is justified on a man's first appointment to a senior position, this must very quickly be followed by a genuine humbleness of outlook toward the responsibilities with which he is faced, and a determination to equip himself for these responsibilities. On the whole, the engineering industry is well managed. Our experience, however, as engineers, tells us that there is nothing that cannot be improved, and this certainly applies to the engineer in administrative matters.

Electric Power

THE domestic and foreign situation, in so far as electric power is concerned, is discussed by Walker L. Cisler, executive vice-president, The Detroit Edison Company, in a pamphlet published through the co-operation of the American Institute of Electrical Engineers, The Detroit Edison Company, the Edison Electric Institute, and the Midwest Power Conference, in the interest of national economy and national defense.

Mr. Cisler pointed out that the requirements presented by the 16 nations of Europe under the Marshall plan for the expansion of their electric power resources call for the addition of about 24 million kilowatts of new generating capacity during the next five years. It cannot be achieved within that time as it would probably require years more to complete because of a number of factors such as capacity of and wartime damage to manufacturing plants, and lack of man power, materials, fuel, and transportation. It is, nevertheless, important from our national defense standpoints that these nations be strong industrially, and to be so, they must have adequate electric power resources even though it will take longer to complete the program, he stated.

According to Mr. Cisler, a healthy peacetime economy is essential to maintaining a strong national defense position. The United States electric power industry is today engaged in the greatest expansion program of its history in order to make

up for what could not be added during the war and to meet post-war load increases.

During the next five years it will construct and put into operation more than 18 million kilowatts of new capacity in public and private plants. If we add to this the existing 52 million kilowatts and more of capacity on the utility systems, we will have a total of more than 70 million kilowatts—an amount far greater than that of any other nation. If to this we then add the present 13 million kilowatts of capacity represented by industrial, transportation, and other plants, plus that which will be added during the next five years to these same classifications, we find that the American domestic, commercial, and industrial user of electric power will have at his command the greatest pool of power that man has ever known.

In general terms, the United States produced in 1947 more than 300 billion kilowatthours of electric power—an amount in all probability equal to the rest of the world combined. It represented energy consumption to the extent of more than 2000 kilowatthours per capita per year. Looked at broadly, this ability to produce and consume electric power in such amounts forms one of our most formidable strategic weapons for both our defensive and offensive requirements.

Mr. Cisler presented the following ways and means of bringing about constructive results which will help to maintain our nation's industrial capacity in time of war:

1 An adequate supply of electric power is essential to both a healthy peacetime economy and to the preparation of and carrying out of a national defense program.

2 During peacetime there should be drawn an effective co-ordinated plan which would provide guidance in the expansion of the electric power industry in relation to defense.

3 The experience of the last war should be drawn upon heavily in planning moves to be made in case of widespread destruction resulting from future hostilities.

4 There should be formed at an early date an Electric Power Industry Advisory Group by the Department of National Defense.

5 The participation of the electric power industry during peacetime in matters involving our national defense would certainly lead to the fulfillment of constructive military objectives. It was one of the most patriotic and co-operative industries during the last war.

6 The maintenance of a position of national industrial strength is, in the author's opinion, the best assurance of the prolongation of world peace. Investment in the industrial system which is recognized as typical of this country is the most hopeful means of defending the nation's traditional way of life.

Mr. Cisler then considered the foreign electric power situation as it concerns the Marshall Plan for the 16 nations of Europe and Western Germany. He said that these nations as a whole have an extensive power program which will greatly increase their total industrial production capacity and materially aid in their social, economic, and political recovery. The extent of the program varies between the respective countries. It is largest in those countries which have already developed their resources to a marked extent for domestic, commercial, and industrial uses. The general program is divided into two parts: (1) a national plan and (2) an international plan.

The national program provides for the installation of 21,445,000 kw of capacity and the international program for 2,306,000 kw of capacity—a total of 23,751,000 kw which is of course a tremendous expansion.

The national program calls for the expenditure of about $5,000,000,000 on the part of the European nations themselves. Assistance from the United States of $300,000,000 (6 per cent) has been asked to cover contingencies in materials and small equipment in the national program. When completed, the generating capacity will be increased 49 per cent over 1947. The international program would be largely provided for by the United States. The total cost is $315,000,000 and the United States is asked to provide large equipment, such as generating units, both thermal and hydraulic, to the value of $200,000,000. It is impossible for such an ambitious program to be carried out within the period anticipated. It will probably require two to four years longer to complete the program even with assistance from the United States in the form of loans, materials, and equipment, Mr. Cisler predicted.

Wartime experience overseas has familiarized us with the electric power systems in northwest Europe and the Mediterranean. Consequently, when the Marshall Plan requirements were examined, the need and importance of such a program were readily understood and recognized.

Mr. Cisler said that undoubtedly our efforts during the war to re-establish their power systems have created a closer and more understanding relationship. A very friendly feeling exists between the electric-utility industry in this country and those over there. This spirit of mutuality has also helped to improve our international relationships.

The following observations were made by Mr. Cisler:

1 One of the best measures of any country's internal economy is given by the amount of electric power it has available and consumed. No modern economy can be fully sustained without adequate resources of electric power.

2 Throughout the world increasingly greater importance is being attached to the development of electric power resources as the basis for the advancement of the social, industrial, and political prosperity of the people. In short, the world has become "power-conscious."

3 Probably more than any other nation, the United States has proved that adequate electric power is vital to extensive industrial production.

4 The five-year plan for electric power development in the countries of Europe within the scope of the Marshall Plan exceeds even the presently known plans for the expansion of the facilities within the United States. It is a highly desirable program but extremely ambitious, and probably impossible to accomplish in less than seven to nine years.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

5 United States loans, engineering, and manufacturing assistance are required in many instances if the world program for electric power expansion is to be carried out within a reasonable time schedule. This raises the question of the impact on our own expansion program.

6 Our outposts are today located on the continents of Europe and Asia. It is highly desirable from a national-defense standpoint that these nations develop electric power resources sufficient to support the industrial economy necessary to make them a potential source of strength in military preparedness. Consequently our stake in the European power situation is one for thoughtful consideration and action.

5,000,000-Lb Testing Machine

A GIGANTIC 5,000,000-lb universal testing machine, built by The Baldwin Locomotive Works, Philadelphia, Pa., for the U. S. Naval Experimental Station, a subordinate unit of the Naval Air Material Center, was demonstrated for the first time officially in the Aeronautical Structures Laboratory at the Philadelphia Naval Base on Sept. 23, 1948, before a group of Armed Forces' officers, civilian engineers, and representatives of schools, engineering societies, and the press. This 5,000,000-lb-capacity machine, the largest of its type in the world at present, will be used for testing the lightest-weight aluminum and magnesium structures that aeronautical engineers can design to meet the severe requirements of modern flight.

The Navy's demonstration of its new testing machine is said to have a double significance:

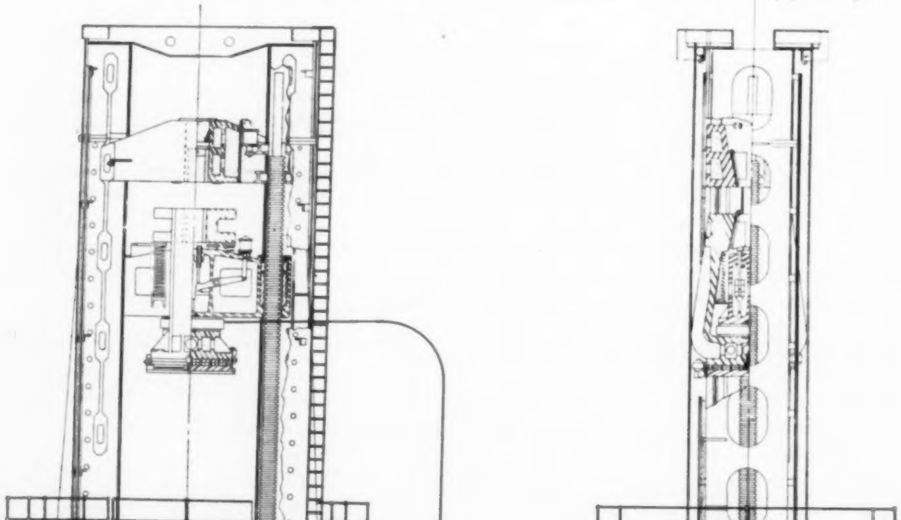
1 It means new possibilities in the development of aircraft structures and in obtaining basic design data. This new machine accommodates specimens up to 30 ft long in tension or compression and up to 50 ft long in transverse loading. The width of the specimens is limited to 10 ft.

The machine, because of its increased size and load capacity, will permit the test of full-size structural elements which could not be tested in the past because of testing-machines inadequacies. Simulated aircraft structural members such as cylindrical elements for fuselages, box beams (the load-carrying members of wings), and plate-stiffener panels will compose the major types of specimens investigated in the machine to achieve the optimum in shape, weight, and strength for actual aircraft members.

2 To the designers of structures and machinery in every field the machine means a widening of the scope of testing. A 5,000,000-lb-capacity machine means that service requirements of any large structure or structural member can be met more certainly by distributing that material in accordance with stress measurements recorded while loading full-size structures. In many instances, proper distribution of material has permitted a reduction of material required and thus a decrease in deadweight of the structure.

The new 5,000,000-lb testing machine operates as follows: Specimens to be subjected to compression or flexure are mounted on the bedplate at floor level or on a leveling table on the bedplate. Tensile-test specimens are held between the sensitive crosshead and the tensile-test crosshead above it. The tensile-test crosshead is rigidly held on the columns at one of several positions spaced about five feet apart.

Load is applied downward by the sensitive crosshead, which is supported on two 55-ft screws, which are in turn supported by arms cast integral with the hydraulic loading cylinder under the bedplate. The weight of this assembly, close to 250,000 lb, is floated on two auxiliary hydraulic cylinders when the machine is not in use. These cylinders are bolted to the main cylinder casting. They serve also as shock absorbers when a test specimen breaks. The hydraulic loading cylinder can move 36 in. downward whereas the piston is stationary, being secured to the bedplate. Hydraulic loading pressure is applied by a 50-hp electric-motor-driven pump of 3000 psi capacity which produces testing speeds up to 3 in. per min. Return speed is 15 in. per min. The sensitive crosshead is positioned by a 100-hp motor rotating the screws by means of drive gears under the bedplate.



U. S. Navy Official Photograph

FIG. 1 FRONT AND SIDE CROSS-SECTIONAL VIEWS OF 5,000,000-LB TESTING MACHINE

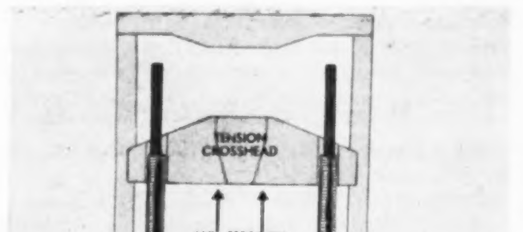
The sensitive crosshead also serves as an elevator for the tension crosshead. It can be raised or lowered at 24 in. per min.

The load-measuring system consists of an Emery cell, carried by the sensitive crosshead, and a Tate-Emery indicator with two indicating dials and accessory equipment. The Emery cell and indicator are connected only by a flexible tubing for transmission of hydraulic pressure.

The Emery cell, which transmits load pressures to the indicator, is essentially a shallow cylinder having a loose-fitting piston and a metal diaphragm so arranged that the load on the specimen produces a pressure change on a thin film of liquid trapped between the piston (and diaphragm) and the bottom of the cylinder. Relative movement of piston and cylinder is practically negligible. The flexible tubing from the Emery cell ends in a Bourdon tube in the indicator.

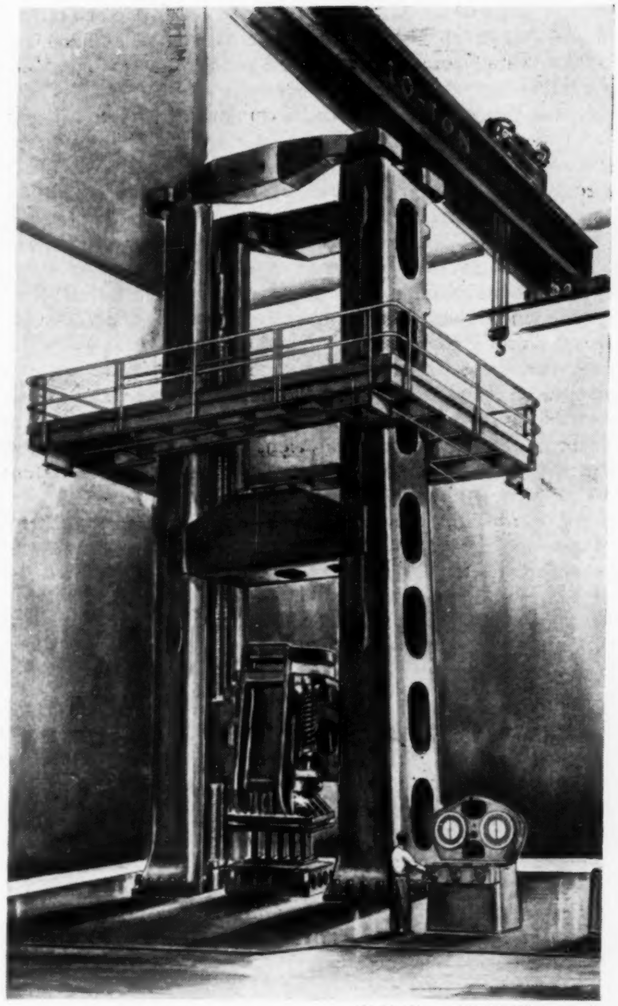
Acceptance tests of the Navy's 5,000,000-lb testing machine showed accuracy within $^1/_4$ per cent of indicated load on all six ranges down to 0–24,000 lb or 0.005 of full capacity. Load variations of only 5 lb can be measured. The hydraulic cylinder applying load is 54 in. in diam and has a stroke of 36 in.

The new testing machine is essentially a hydraulic press. However, the necessity for accurately measuring applied loads, often off center, is an important consideration in design. Three design features maintain minimum tolerance in horizontal deflections under load, prevent premature buckling of compression specimens, and neutralize horizontal components of force. These are as follows: (1) crossed flex-plate fulcrums or stays between the sensitive crosshead and its sensitive yoke, (2) adjustable guides for the sensitive crosshead, and (3) flaring of columns at the base.



U. S. Navy Official Photograph

FIG. 2 PRINCIPLE OF OPERATION OF 5,000,000-LB MACHINE



U. S. Navy Official Photograph

FIG. 3 ARTIST'S DRAWING OF 5,000,000-LB TESTING MACHINE

One of the machine's accessories is a catwalk elevator surrounding the machine with a capacity of 8000 lb. For the safety of the operator the control and indicator cabinet is located at one side where tests can be watched and controlled most conveniently. A safety screen, consisting of separate interlocking plates with large $^1/_2$-in-thick safety glass windows through which tests can be observed safely at close range, has also been provided.

Erection of the machine was complicated by the fact that the roof supporting structure of the laboratory is just above the top of the machine, which reaches 47 ft above the floor. (It extends 16 ft below.) The supporting columns had to be made in two parts for this reason. The largest single piece of the machine is the steel bedplate casting, weighing approximately 100,000 lb. The 136,000-lb "sensitive" crosshead is the largest subassembly.

Two tests, a tension and compression, were performed for the visitors on the 5,000,000-lb machine. In the first test, a forged 1040 steel tension specimen, approximately 12 ft long, was tested. The test section of this bar was 8 in. in diameter with a cross-sectional area of 50.3 sq in. This specimen was expected to

yield or "neck down" at a load of about 2,500,000 lb and fail at about 3,750,000 to 4,000,000 lb. It actually failed at 4,200,000 lb, the failing point being marked with a resounding crash much like that of medium artillery fire.

In the compression test, an aluminum-alloy plate-stiffener panel made of $^1/_2$-in. 75S-T alloy plate joined to heavy extruded angle sections with $^1/_2$-in-diam rivets, was used. This specimen failed at 3,580,000 lb also with a loud crumbling crash. As the panel failed, the rivets sheared off and struck the safety shield with machine-gunlike rapidity and such force that the rivets actually cracked the $^1/_2$-in-thick glass.

The Bureau of Aeronautics and the Naval Air Material Center announced that they plan to extend the use of the 5,000,000-lb test machine to other bureaus and activities of the Navy Department, to other Government departments, and to contractors to the Government. Arrangements may also be made for the use of the machine by private institutions engaged in scientific research and investigations leading to increase in engineering knowledge, subject to availability considerations and to approval by the Bureau of Aeronautics.

All tests will require the authorization of the Bureau of Aeronautics and the costs will be at the expense of the activity for whom the tests are conducted.

Tonnage Oxygen

THE impact of tonnage oxygen on the American chemical industry was discussed by Charles R. Downs, chemical engineer and investigator, New York, N. Y., before the 1948 annual meeting of the Chemical Market Research Association.

Mr. Downs stated that oxygen of 99.5 per cent purity, presently used mostly for cutting and welding purposes, has been produced in this country for many years. The capacity of such plants today is usually from two to ten tons per day, but a few have been built for as much as 150 tons per day in a single unit. These plants are scattered throughout the country, primarily for distribution purposes.

A tabulation of the production of 99.5 per cent oxygen produced in the United States since 1919 in rounded figures of billions of cubic feet per year shows the trend to be as follows: 1919, 1.17 billion cu ft; 1929, 3.14; 1933, 1.82; 1941, 7.18; 1943, 20.48 (the maximum war year); 1946, 10.87 (a reduction due largely to strikes in steel and coal production); and 1948, at the rate of about 15.5 billion cu ft per annum.

According to Mr. Downs, the delivered sales prices of oxygen for cutting and welding purposes (99.5 per cent purity) within a short transportation radius may be assumed to be approximately as follows: 10 tons per month, $120 per ton; 85 tons per month, $77 per ton; 190 tons per month, $64 per ton.

For experimental purposes, which require large quantities of oxygen, prices have been reported to be as low as one half the last-named figure. Such a price is, however, far above the cost of production of gaseous 95 per cent oxygen in large plants.

Beginning about 1930 in Germany, plants were developed for the production of oxygen of lower purity (90–95 per cent) on a much larger scale than formerly attempted. Such plants reached a capacity of 120 tons per day in a single unit, and this development has been continued in the United States where single units of about 1000 tons per day are under construction.

The rated capacities of plants being built in tons per day of 90–95 per cent oxygen are as follows:

1 For Bethlehem Steel Company, Johnstown, Pa., for iron and steel production, about 150 tons per day.

2 For Carthage Hydrocol Company, Brownsville, Texas, for hydrocarbon synthesis process, about 2000 tons per day.

3 For Stanolind Oil & Gas Company, Garden City, Kan., for same purpose and approximate tonnage of item 2.

4 For McCarthy Chemical Company, Winnie, Texas, for partial oxidation of hydrocarbons, about 175 tons per day.

5 For Weirton Steel Company, Weirton, Pa., for iron and steel production, about 400 tons per day.

6 For E. I. du Pont de Nemours & Company, Belle, W. Va., ammonia department, about 360 tons per day.

7 For Wheeling Steel Company, Stuebenville, Ohio, for iron and steel production, about 135 tons per day.

Note should be made that the Carthage Hydrocol and Stanolind plants each contain only two units of 1000 tons per day capacity which are vastly larger than any units heretofore designed.

The estimated annual production capacity of the seven plants now building is 5220 tons per day or 40 billion cu ft per year of 90–95 per cent oxygen versus $15^1/_2$ billion cu ft, the present rate of production of 99.5 per cent oxygen and $20^1/_2$ billion cu ft, the peak war-year production. Thus the estimated production of 90–95 per cent oxygen from these seven plants will be about twice the tonnage of all plants at the peak of the war.

There are many potential uses of 95 per cent oxygen, some of which are as follows:

1 *Synthetic Liquid Fuels.* Two principal processes are used to make synthetic liquid fuels, the Bergius process and the hydrocarbon-synthesis process, both of which require low-cost oxygen.

2 *Iron and Steel Industry.* Work is commencing on the use of oxygen-enriched air in blast furnaces for the production of pig iron, ferromanganese, and other ferroalloys; investigations of the use of low-cost oxygen in open-hearth furnaces has been reported as having been made by at least 24 U. S. steel companies; and the use of oxygen-enriched air in Bessemer converters has been found to greatly reduce blowing time and permit the addition of a greater ratio of scrap to hot metal.

3 *Sulphide Ores and Sulphur Products.* The sulphide ores of copper, nickel, zinc, and lead are smelted in reverberatories, converters, roasters, and blast furnaces of various types using air to oxidize them to sulphur dioxide, which is diluted with nitrogen. A moderate enrichment of the air blast with oxygen will make the sulphur-dioxide content sufficiently concentrated for the recovery of sulphuric acid in existing types of catalytic converters or lead chambers.

4 *City Gas.* Oxygen may be used in the future for making water gas and for reforming natural gas.

British Machine-Tool Exhibit

THE first machine-tool exhibition held in Britain since 1934 took place in London, England, Aug. 26 to Sept. 11, 1948. It showed the products of more than 230 firms, some 25 per cent of them overseas manufacturers.

Almost all the British machines exhibited were of postwar design or new developments and improvements of prewar types.

There were machines of all types on display, weighing anything from a few pounds to more than 100 tons, and representing every aspect of this diverse complex industry. One quarter of the 200,000 sq ft was allotted to the products manufactured overseas. The main overseas countries exhibiting were the United States, Switzerland, and Belgium. Their products ranged side by side with British products.

Among many interesting machines displayed by British manufacturers for the first time were the following: A new type of automatic contouring device which works on a profile template system and is accurate to 0.0005 in. and manufactured by

Metropolitan-Vickers Electrical Company, Trafford Park, Manchester, England; a jig-boring machine accurate to 0.0003 in. made by Newall Engineering Company of Old Fletton, Peterborough, Northants, England; a new hobbing machine for hobbing worn wheels, the smallest in a range of movingtable machines. This machine has a capacity up to 15 in. in diam and has been designed on modern lines with a clean attractive outline combined with high productivity and universal adaptability. Manufacturers are David Brown Company, Britannia Works, Sherborne Street, Manchester 3, England.

One interesting example of modern lathe design is a $6^3/_8$-in. center cutting lathe having a bed six or seven feet long. It is capable of sliding feeds of 20 to 600 cuts per in., and surfacing feeds 30 to 960 cuts per in. It is suitable for almost all manner of turning operations. This lathe is made by Dean Smith and Grace Company of Worth Valley Tool Works, Keighley, Yorks, England.

Another exhibit which aroused much interest was a multitool lathe in which several tools cut simultaneously on one workpiece. These machines have an automatic cycle. All that the operator had to do was insert each workpiece and move the starting handle. The machine does the rest, the different tools automatically cutting in as necessary. Drummond Brothers of Rydes Hill, Guildford, Surrey, England, are the manufacturers.

One "historic" exhibit which attracted much attention was the Maudsley's wooden pulley and block shaper. (Maudsley was the inventor of the slide rest which revolutionized the lathe.) Built in 1800 this machine made pulleys and blocks for the Royal Navy in Nelson's time and was in continuous use right up to 1944 when it produced pulleys and blocks for the modern navy. It is claimed to be the world's first mechanical machine tool.

Mr. George Strauss, Britain's Minister of Supply, when opening the exhibition, stated that it is now almost certain that in 1948 the total British output of new metalworking machine tools alone will exceed £30,000,000 ($120,000,000) worth; the output in 1935 was £6,500,000 worth. Woodworking machines are expected to reach £5,000,000 in valuation this year, as compared with an output of less than £1,000,000 in 1935. The British machine-tool industry is aiming at an export target of £20,400,000 ($81,600,000) per annum—some 60 per cent of its total production.

White-Speck Lumber

SOME recent observations on the presence of white speck (more accurately and preferably termed white pocket rot) in lumber have focused attention on its use in building construction, according to the U. S. Forest Service. The topic is of increased interest because of the present commercial harvesting of timber stands in which trees contain considerable amounts of white speck. Formerly, trees of this type were often left to waste in the woods, or were not accessible to the logging industry. In the interest of conservation it is desirable to use lumber containing white-speck where use requirements permit.

The U. S. Forest Service points out that there are many satisfactory uses for lumber containing white speck. High strength is not generally required for sheathing, core stock, subfloors, and roof boards, and white-speck lumber may be used for these purposes. When used for joists, studs, and framing in house construction, care should be taken to select a grade that will provide sufficient strength for the purpose intended.

Pending further examination of the subject, white-speck lumber should not be put to structural uses that have a high strength requirement. As currently graded, white-speck lumber is not admitted in the grades of lumber designed to meet such high strength requirements.

It is important that users understand clearly the nature of white speck and the limitations imposed on the use of lumber containing it. White speck is caused by the fungus, Fomes pini, which destroys wood cell structure in progressive degrees. In its final stages the rot riddles the heartwood with spindle-shaped pockets which are lined with strands of nearly pure cellulose. After the lumber containing Fomes pini has become continuously dry (less than 20 per cent moisture content, which is normal for housing lumber not exposed to the weather), the fungus will not progress further. If it becomes wet again, white-speck lumber, like lumber free from this defect, is subject to decay caused by other fungi.

Knots and other growth characteristics reduce strength according to their magnitude. White speck in the advanced stages of decay likewise materially reduces the strength of wood in bending, compression, toughness, and stiffness. The reduction in strength is gradual, beginning just before the advanced stage is reached and increasing as decay progresses. U. S. Department of Agriculture Bulletin 779 shows that in the advanced stages of decay, bending strength is reduced as much as 50 per cent, compared to clear lumber free of all defects. Likewise, compared to clear lumber, compression is reduced as much as 30 per cent; impact as much as 40 per cent; and total work in bending as much as 80 per cent. Since lumber containing white speck provides lower strength values, commercial standards classify lumber containing white speck—as well as that containing large knots, knot holes, shake, and split—into the lower grades which are not expected to furnish high working strength.

When high nail-holding power is a definite requirement, allowance should be made for reduced nail-holding power. More nails or larger nails or both would be required to obtain the same holding power.

For practical purposes the effect of Fomes pini in reducing the strength of lumber does not progress beyond the time at which the lumber is manufactured. Thus it is possible to classify and grade white-speck lumber properly to meet specific use requirements at the time of manufacture.

Pulsejet Helicopter

THE completion of successful test flights of what is claimed to be the first known pulsejet-powered helicopter was announced recently by The General Tire & Rubber Company, Azusa, Calif. The aircraft was designed and built by General Tire's recently acquired Marquardt Aircraft Company, Venice, Calif.

This new helicopter, called the Marquardt M-14, differs from the conventional-type helicopter in that power is supplied by two pulsejet engines, one mounted on each tip of the rotary wing. The pulsejet engine is an explosion-type engine having reedlike valves in the air inlet as opposed to the ramjet or continuous-burning engine. No other power source is required. Fuel and ignition are supplied to the jet engines through lines integral with the structure of the rotor blade.

Extremely simple in design and entirely free of the necessary installations of the mechanically driven helicopter, it is said that the Marquardt M-14 will carry twice the pay load of equivalent conventional helicopters for relatively short distances.

According to Marquardt engineers, the elimination of expensive and complex equipment permits a much lower comparative initial cost and insures greatly reduced operational and maintenance costs. They predict unlimited applications for the

FIG. 4 TEST-STARTING PULSEJET HELICOPTER

pulsejet-powered helicopter emphasizing for military use the transportation of heavy equipment in the field, especially at river crossings or other barriers. Commercially, it would be economically superior for short-haul operations of cargo or passengers, being adaptable to airport-to-city shuttle service.

The M-14 has been designed primarily as an experimental flying test rig with little consideration being given at this time to a utility aircraft. The method of starting the engines after fuel and ignition are supplied is merely to supply a jet of air from an auxiliary air compressor manually directed into the nose of the engines. As soon as resonance occurs, the jet of air is removed and the rotor is freed for powered rotation. In a utility aircraft a built-in starting system would be used. This would consist of an air compressor and tank in the fuselage, with transmission of air to lines integral with the rotor blade by means of a rotary seal similar in function to the rotary seal now used for the fuel system. The ignition source is a common spark coil and battery passing current through slip rings on the rotor hub.

The helicopter was first tested at the Muroc Air Force Base with further ground, hovering, and flight tests being conducted at the Torrance (California) Municipal Airport. It is reported that the ship was found to be stable beyond expectations in hovering and forward flight. This is attributed to the mass of the jet engines at the extreme tips of the rotor blades. To date the M-14 has flown only at low altitudes and low speeds, consequently limiting the performance data.

Reports From Germany

Oil-Shale Carbonization

A COMPREHENSIVE technical report on the carbonization of oil shale, prepared by a German expert, Dr. Walter H. Oppelt, is now available, the Office of Technical Services, Department of Commerce, announced recently.

According to an introductory note, the report was written by Dr. Oppelt preparatory to signing a contract for employment in the United States as a means of indicating the type of information in his possession. The report, in typewritten manuscript form, has not had general distribution.

Dr. Oppelt was asked to draw up plans for two projects. The first project called for designing a commercial plant for the daily production of 8500 barrels of crude shale oil, to include a suitable process for carbonizing the fines obtained from crushing and screening so that they would not be wasted.

The process for carbonizing the coarse shale in the commercial plant, as described by the author, involves drying and preheating the shale with superheated recirculating carbonization gases. The fixed-carbon residue of the spent shale is burned; the resulting hot combustion bases provide the heat energy to superheat the drying steam and the purging carbonization gases. The production scheme calls for a new furnace design which includes properly separated zones for drying and preheating, carbonizing, and burning the fixed carbon.

Since almost no process is known which is suitable to handle the fines, the author states, a new process was designed which consists of a drier, storage bunker, and furnace. A conveyer-type drier was applied because it solves two problems, drying the shale and transporting it to the carbonization system.

The second project Dr. Oppelt was asked to develop and report on involved the design of a pilot plant which in operation would provide basic information on various phases of commercial oil carbonization. The pilot plant designed calls for a highly flexible storage and disintegrating system to provide storage space for various types of oil shale; a transportation system; and furnaces for carbonizing the coarse shale and the fines.

Both projects as developed by the author are discussed in considerable detail in the 366-page report (PB-89704), "Carbonization of Oil Shale." Included also are detail drawings of the commercial and pilot plants and their component equipment. Photostat copies sell for $37. Microfilm copies are $7.

Orders for the reports should be addressed to the Library of Congress, Washington 25, D. C., accompanied by check or money order payable to the Librarian of Congress.

High-Voltage Direct-Current Transmission

Development of high-voltage direct-current transmission was favored by German aviation authorities before the war since this type of electric distribution made possible substitution of underground cables for overhead lines carrying alternating current, according to a report now available, the Office of Technical Services, Department of Commerce, announced.

The report is a comprehensive review of the theory and practice of German high-voltage long-distance transmission and includes an account of experiments undertaken in replacing alternating current with direct current on proposed 400-kv lines.

The original German text by Dr. Ing. F. Busemann, of Siemens-Schuckert A.G., Berlin, has been translated by Alexander Dovjikov, U. S. Department of the Interior, Bonneville Power Administration. The translator states in his introductory notes: "We believe that Dr. Busemann's report is of such fundamental and general interest that it should be brought to the attention of American engineers, even if we may not fully agree with some of his statements."

The German State Secretariat for Aviation held that overhead lines not only impeded construction of airports, but also facilitated the location of important targets. Hence this organiza-

tion had a major interest in the development of high-voltage direct-current transmission (HVDCT). The German utility companies were also interested in HVDCT because its adaptability to underground cable construction indicated a way of lessening atmospheric disturbances to which overhead lines are vulnerable during storms, sleet, and other adverse weather conditions. In addition, the utility companies were considering the use of HVDCT for increasing the capacity of existing overhead lines operating on alternating current because it could carry the same current load with a smaller conductor.

The report concludes that development work had proceeded far enough in Germany to put three-phase 400-kv systems into immediate construction, but that direct-current lines of the same capacity still have design problems to be overcome. Specifically, satisfactory mutators for continuous operation and adequate short-circuit breakers were still problems to be solved.

If the long-distance transmission for pressing reasons has to be made by underground cable, the direct-current transmission has advantage in every case, the report states. It points out that for overhead lines economies must be carefully studied in each particular case.

The report (PB-86272, "High-Voltage, Long-Distance Transmission," 66 pages, plus diagrams, illustrations, and bibliographics) sells for $10, photostat; $3.25, microfilm. Orders should be sent to the Library of Congress, Photoduplication Division, Publication Board Project, Washington 25, D. C., accompanied by check or money order payable to the Librarian of Congress.

Also obtainable from the Library of Congress is a comprehensive survey of the German power industry prepared under OTS auspices (PB-11197, 427 pages, photostat, $29; microfilm, $4.50).

High-Pressure Hydrogenation

A comprehensive monograph report on German research and industrial practice in the field of liquid-phase high-pressure hydrogenation of carbonaceous matter, is now on sale by the Office of Technical Services. Used primarily as a first step in the production of gasoline, the hydrogenation process is versatile and permits the manufacture of fuel oils, briqueting agents, and the like.

The process, the report states, was an outgrowth of methanol and other high-pressure studies carried on by Dr. Mathias Pier and his colleagues at the I. G. Farben laboratories, at Ludwigshafen, Germany.

Hydrogenation of coal, tar, and oil was the source of 97.5 per cent of German aviation gasoline and 47 per cent of all hydrocarbon products in Germany during the later war years, the report states. The first reported work on high-pressure hydrogenation of carbonaceous matter was that of Bergius in 1911. The Bergius noncatalytic process continued until 1930 when it was displaced by the more successful catalytic process developed by I. G. Farbenindustrie under the leadership of Dr. Pier.

The report contains flow sheets for the hydrogenation of petroleum residue, brown coal, coal tar, and bituminous coals and pitches. The suitability of various raw materials for hydrogenation in the liquid phase is discussed in detail, as is the chemistry of coal hydrogenation. The chemistry of the liquid-phase thermodynamic efficiency of coal hydrogenation, effects of various catalysts on the liquid phase, influence of various conditions on the product, equipment used, control instruments, and methods of analysis are among many other subjects discussed. The report is illustrated with flow sheets, diagrams, and tables throughout. The 244-page report (PB-88839, "High Pressure Hydrogenation in Germany, The Liquid Phase,") sells for $6.25. Orders for the report should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

Gas-Turbine School

THE first school of gas-turbine technology to be established in Britain—and it is believed to be the first in the world—is described by William Holt, British writer and broadcaster, in a special article received through the courtesy of British Information Services. It is located at Lutterworth, near Rugby, England, where Air Commodore Sir Frank Whittle made his first jet engine. The school has grown out of Sir Whittle's experimental work and the teaching of the technical knowledge when the experience was passed on to the aero-engine industry during World War II. The school was opened for Service personnel.

According to Mr. Holt, the school has been organized by Power Jets (Research and Development) Ltd., to promote fundamental knowledge in design and operation of gas-turbine engines and to stimulate demand for gas-turbine technology among potential users. It is open to students from any country. The courses last from two to three weeks. At present they are designed for graduate engineers, but it is proposed to arrange practical courses for testers, engineers, and operators. Some of the students now at the school will manufacture these engines. Many of the students who attend the school are themselves teachers, so this teaching of gas-turbine technology is having a snowball effect and is helping to speed up the growth of the new gas-turbine industry. The school is nonprofit-making, but it is also nonloss-contracting. The students pay a tuition fee to cover the cost of running it. At present this fee is $63 a week. Accommodation and all meals are provided in the school's hostel for an inclusive charge of $14 per week. There is room for only 20 to 30 students at a time at the school at present.

The aero-engine and the industrial courses both cover basic theory and the practical testing of gas turbines and they include lectures by specialists on a wide variety of correlated subjects such as fuel technology, combustion components, and metallurgy. Engines of various manufacturers are there complete and in parts, such as the Rolls-Royce Nene and the Derwent I and the Derwent V, the de Havilland Goblin and the

FIG. 5 PUPILS STUDY A SKELETON OILING SYSTEM ON A GAS-TURBINE ENGINE

Rolls-Royce Trent. Students examine and test them and take them apart. Some of the engines have been sectioned so that they can be studied more easily. There are charts on the walls and turbine disks against them.

The following is an outline of the syllabus of a three weeks' Industrial Gas-Turbine Course:

Theory. Symbols and units. Basic thermodynamics leading to cycle performance and basic design. Temperature-entropy diagrams for calculation of engine performance. Specific-heat and fuel calculations. Theory of flow applied to nozzles, blades, jets, and pipes. Theory of centrifugal and axial-flow compressors and turbines. Actual performance calculations from the test of an engine. Cycle calculations with intercoolers, reheat, and heat exchangers. Consideration of well-known industrial cycles. Part-load performance.

Practical. Test procedure and instrumentation. Testing of an engine in the school testing house. Workshop processes used in gas-turbine manufacture. The precision method of blade manufacture.

Specialist Subjects. Fuel technology (liquid fuels). Pulverized fuels. Burners and combustion equipment. Bearings and lubrication. Gearing. Land installation. Marine installations. Locomotive installations. Centrifugal compressors. Axial-flow compressors. Turbines. Gas-turbine manufacture. Visits are made to the manufacturing departments and the experimental departments of the National Gas Turbine Establishments at Whetstone, Middlesex.

In addition to its own teachers, the school receives the support of outside lecturers with special knowledge and experience. Mr. Holt relates that R.H.H. Barr, of Centrax Power Units Ltd., lectured on Gas Turbines for Road Transport. Mr. Barr's firm designed and built the gas-turbine engine for road transport that was shown at the recent British Industries Fair —a pistonless engine without clutch or gearbox (see MECHANICAL ENGINEERING, August, 1948, p. 692). He dealt with such problems as the mass-production of disks and turbine blades of a size small enough for an automobile engine. The engine is only 17$^1/_2$ in. in diam and 3 ft long.

U. S. Air Force

THE United States Air Force, which celebrated Air Force Day on September 18, marking the end of one year as one of the three coequal military services, has introduced 13 new models of aircraft during the year and continued with the testing and modification of models built in previous years.

This year has seen the development of the Air Force's first parasite jet-fighter, flight of the world's largest transport airplane, and the addition of several types of high-speed fighters and jet-bombers.

Numerous modifications have been made on existing aircraft and aircraft engines as a result of the Air Force's research and development program, and a USAF flying laboratory has penetrated the sonic barrier, marking the first time that man has flown faster than the speed of sound

Among the new aircraft are four fighter-type airplanes, three transports, two bombers, a high-speed trainer, a pilotless jet target airplane, a helicopter, and a cargo glider.

The Curtiss-Wright F-87 all-weather fighter was rolled out last September to begin ground and air tests. With four jet engines, the F-87 carries a two-man crew and was designed for all-weather operation. The high-speed fighter completed its first test flight in March, 1948, and a month later Curtiss-Wright was awarded a $1,500,000 contract for engineering and tooling preparatory to production of the new airplane, which, however, will have only two jet engines. The original model was powered with four Westinghouse 24C engines (J-34).

North American's F-86, a single-seat low-wing fighter with a pressurized cabin, powered with an Allison J-35 engine, completed its first tests in November, 1947. With wings swept back at an angle of 35 deg, the 650-mph F-86 has a combat radius of more than 500 miles and a service ceiling of more than 40,000 ft. Production models use the General Electric J-47 engine. (See MECHANICAL ENGINEERING, January, 1948, p. 26.)

The Lockheed TF-80 Shooting Star, a two-seat model of the original jet-propelled F-80, powered with the Allison J-33 engine, began flight tests late in March, 1948. Intended for use as a training airplane, the TF-80 met the need for a jet plane in which to furnish transition training for student fliers in jet-fighter operation and the split-second navigational problems incident to high-speed flight.

In May, 1948, the McDonnell XF-85 parasite fighter was introduced. A wheelless airplane, the XF-85, was designed to be carried to its mission area in the bomb bay of the B-36 and released for combat at or near the target point. The folding wings of the XF-85 and the compact design of the parasite required special provisions for pilot safety. Its power plant is the Westinghouse J-34 (24C). (See MECHANICAL ENGINEERING, August, 1948, p. 686.)

On Sept. 12, 1947, the Boeing XB-47 Stratojet was rolled out. Powered by six J-35 jets and comparable to the B-29 in size, the XB-47 completed the first phase of its flight tests in April, 1948. (See MECHANICAL ENGINEERING, November, 1947, p. 943.)

The B-49, Northrup's Flying Wing—a jet version of the conventional engine XB-35—made its first test flight on October 21, 1947. (See MECHANICAL ENGINEERING, December, 1947, p. 1028.) On November 24, 1947, the Consolidated-Vultee XC-99 transport, the world's largest landplane, was flown. (See MECHANICAL ENGINEERING, February, 1948, p. 145.) Also in November, 1947, Fairchild Engine and Airplane Corporation received a contract for production of 37 C-119's, an improved version of the C-82 Packet. Another new transport was the Lockheed C-121, a modified version of the C-69, substantially the same as the cargo-carrying Lockheed Constellations now being used by commercial airlines.

Earliest new airplane development during the year of autonomy was the test flight of Bell Aircraft's XH-12, a helicopter with a top speed of 105 mph, capable of a 13,000-ft service ceiling, which hovers as high as 4350 ft.

The only glider introduced by the Air Force in this year was the Chase CG-18A Avitruc, an all-metal assault glider, equipped with a cargo ramp.

In March, 1948, Fairchild received a contract for construction of the detachable fuselage XC-120 Pack-plane. Making use of the truck-trailer principle, the XC-120 design specifications called for a "pack" which could carry a nine-ton pay load for a 2000-mile range.

In July, 1948, the Air Force contracted with North American for the production of 266 T-28's, a single-engine, low-wing fighter-trainer to be used in primary and basic flying training.

The XQ-2, a pilotless, jet-propelled target plane, was ordered in service test quantity from Ryan Aeronautical Company in August, 1948. A joint Air Force-Navy project, the XQ-2 will be approximately half the size of a standard fighter plane and is designed for use in antiaircraft practice and in air-to-air gunnery training.

The Lockheed F-80 Shooting Star underwent two major modifications. The first involved the installation of a water-alcohol fuel-injection system for greater engine power. The second, completed in June, 1948, was incorporated in the F-80C, and involved the installation of a more powerful Allison turbo-jet engine, the J-33-23, capable of giving a rated 4600-lb thrust

at take-off. The engine change raised the F-80C's speed into the 600-mph class.

In an exhibition at New York's Idlewild International Airport, the Fairchild C-82 Packet demonstrated the practicability of the new track-tread landing gear which reduced the pressure of this aircraft on the ground from 60 to 20 psi. (See MECHANICAL ENGINEERING, August, 1948, p. 686.)

One new engine was accepted during the year. The General Electric J-47A was test-flown in North American's F-86 fighter. With approximately the same dimensions and weight as the 4000-lb-thrust J-35 used in the original F-80, the J-47A developed 5000 lb thrust on take-off. (See MECHANICAL ENGINEERING, August, 1948, p. 693.)

The J-33-21, developed under Air Force sponsorship by the Allison Division of General Electric, was released by the Air Force to approved airframe manufacturers for potential use in commercial aircraft.

On March 10, a USAF B-29 Superfortress carried a 21-ton bomb high above Muroc Lake and dropped it—the largest bomb ever dropped from an aircraft. (See MECHANICAL ENGINEERING, May, 1948, p. 444.)

An analysis of the research and development program conducted by the U. S. Air Force indicates that a majority of the cost of the program is spent on contracts with civilian organizations—with universities and other nonprofit agencies for research and with industrial firms for development.

The Air Force received research and development appropriations of $225,000,000 for the current fiscal year ending next June 30.

Approximately 80 per cent of this sum will be spent on contracts with civilian organizations, 15 per cent for the pay of civilian employees, and five per cent for the maintenance of facilities and the purchase of modern test equipment.

At the present time, the USAF has 226 basic research contracts with 57 educational institutions and nonprofit organizations throughout the United States.

Besides its own research, and research it finances with civilian agencies, the Air Force frequently consults with research and development groups in other military and governmental agencies.

In addition, however, the Ordnance Department of the Army develops machine guns for the Air Force, and the Signal Corps its long-range ground-to-ground radio. Other agencies which co-operate with the USAF research and development program include the Corps of Engineers, the Chemical Corps, the U. S. Bureau of Standards, the Bureau of Mines, the Navy's Bureau of Aeronautics, and the National Advisory Committee for Aeronautics.

NACA supplies valuable research data in the fields of aerodynamics and thermodynamics. Co-ordination of these projects among the military services is handled by the Secretary of Defense's Research and Development Board, of which Dr. Vannevar Bush is chairman.

The Air Force program is now conducting studies in all-weather flying, guided missiles, electronics, climatic projects, supersonic speeds, aeromedical problems, aircraft structures, armament, photography, power plants, propellers, landing gear, communications systems, and other materiel.

In an effort to obtain the services of outstanding scientists, Congress has authorized the employment of 15 of them at salaries ranging from $10,000 to $15,000 a year.

The Air Force also has access to the knowledge of a number of outstanding American scientists who are members of the Scientific Advisory Board to the Chief of Staff of the USAF. This board was created in 1944 by General of the Army Henry H. Arnold to advise him on aeronautical matters. Dr. Theodore von Kármán, Mem. ASME, director of Guggenheim Aeronautical Laboratories, remains as chairman, having been appointed by General Arnold to head the board when it was organized. The 33 members of the board are leading scientists of industrial organizations and educational institutions; all donate their services to the Air Force without pay.

The board is divided into six panels: aircraft fuels and propulsion, guided missiles, electronics and communications, weather and upper-air research, explosives and armament, and aeromedicine and psychology.

Technical Information Committee

FORMATION of a Special Committee on Technical Information to promote effective exchange of research and development information among the departments of the National Military Establishment was announced recently by Dr. Vannevar Bush, chairman of the Research and Development Board, National Military Establishment.

The committee will study the problem of collecting, correlating, reproducing, and disseminating technical information potentially useful in the research and development program of the National Military Establishment. Study and application of new methods and techniques to the problem of technical information organization, and promotion of active research in this effort, are expected to receive especial attention by the group.

At the first meeting of the committee, Dr. Detlev W. Bronk, chairman, pointed out the desirability of applying scientific methods to utilize more effectively the large body of information created by scientific activity.

"The handling of results of research in the matters of publication, dissemination, and assimilation has not in the past shown an experimental or adventurous approach," Dr. Bronk stated.

Dr. Bronk, recently appointed president of Johns Hopkins University, is also chairman of the National Research Council and Foreign Secretary of the National Academy of Sciences.

Membership of the Special Committee on Technical Information includes Prof. John E. Burchard, Dean of Humanities, Massachusetts Institute of Technology; Herman Henkle, Director of the John Crerar Library; Lieut. Col. F. L. Walker, Jr., Army; Captain W. H. Leahy, Navy; Colonel Bernard A. Schriever, Air Force. Norman T. Ball is executive director of the committee.

Tractor Production

THE production of an all-welded tractor frame and clutch case was described at the 1947 ASME Annual Meeting by Charles A. Davis, Mem. ASME, and Wilfred C. Cadwell, Caterpillar Tractor Company, Peoria, Ill.

The frame and steering clutch-case assembly, Fig. 6, chosen as the subject of the paper, constitutes the principal structural unit of the Model D7 Caterpillar Diesel tractor.

The actual production of this assembly has many interesting aspects, not only because the parts are completely welded, but also because the rate of production must be consistently high enough to meet the demands of the tractor assembly line.

Welding of all of the subassemblies is performed in a series of adjacent welding booths with connecting conveyer which serves to transport the parts to the tacking fixtures in preparation for final welding together.

The various plates comprising the subassemblies are blanked

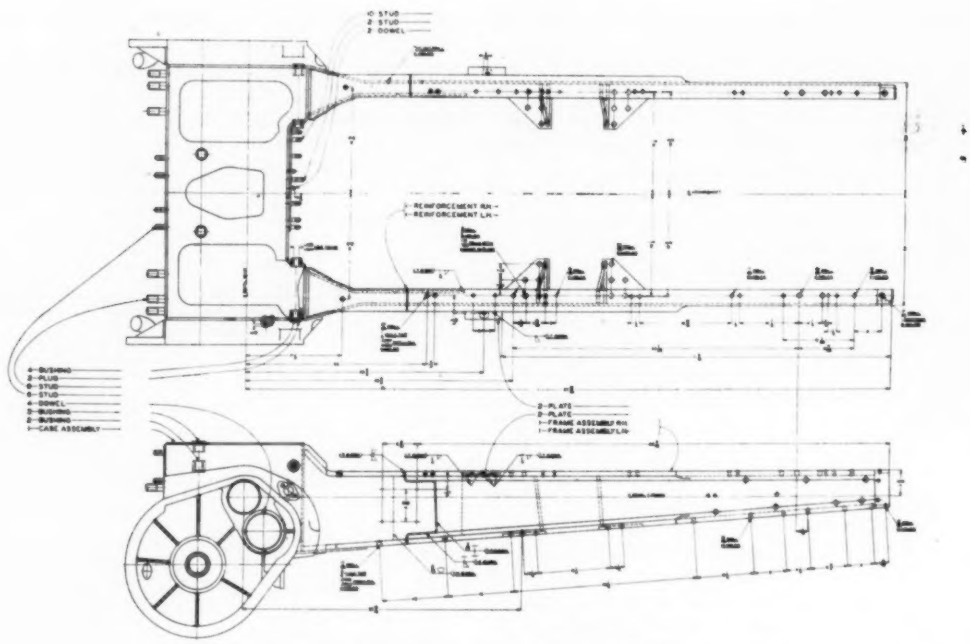


FIG. 6 FRAME AND STEERING CLUTCH-CASE ASSEMBLY

and formed before welding. A huge hydraulic press does much of this work. Blanking of the large plates used for rear-plate assembly and top-plate assembly is performed in a single stroke of this machine.

Smaller presses located along the welding line are used to restore alignment of the subassemblies when this has been disturbed by welding. Experience has indicated that when straightening can be done safely it is more advantageous, giving more uniform final alignment in all parts, than attempting to control the slight distortion which occurs to some extent anyway, by closer regulation of the order and distribution of the welding. This latter important phase of the art is certainly not overlooked altogether, for all the assemblies are welded in specified sequences which are graphically illustrated for the guidance of each welder. But the most careful practice seems to admit just enough possibility of distortion to cause troublesome lack of interchangeability on machine tools and tool equipment in the shop as well as on machines in the field.

All of the subassemblies are tacked together in rigid fixtures. From the tacking fixtures the cases are placed on Ransome positioners, each welder completing the welding on any one case. A partially welded unit is shown in Fig. 7, and in the same photograph a case, complete except for side plates, may be seen on the roller conveyer.

Following welding, each unit is tumbled for removal of weld flux and general cleaning. After this operation each case is tested for leaks before passing to the milling setup for the preparation of locating pads. This fixture and mill permits all important areas to be targeted for stock required by subsequent machine operations before the three-dimension locators are milled in this operation.

The left and right-hand side-frame members, essentially tapered I-beams of a symmetric section, are welded of a trapezoidal plate which forms the web, and two special T-sections which constitute the flanges. The submerged-arc welding is performed from one side only against a suitable back-up plate, penetration being 100 per cent.

Before the attachment of the side frames, the case moves to

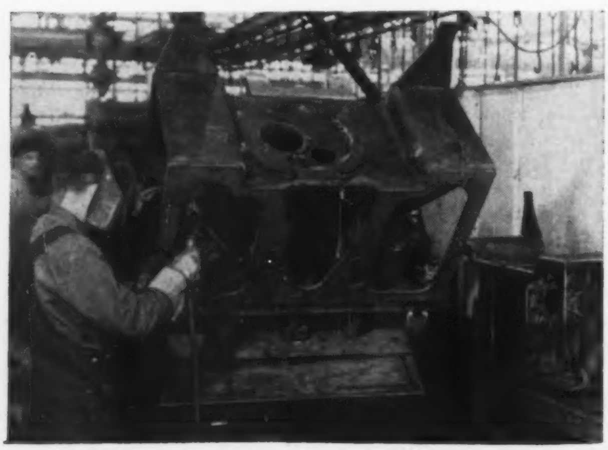


FIG. 7 PARTIALLY WELDED CLUTCH CASE

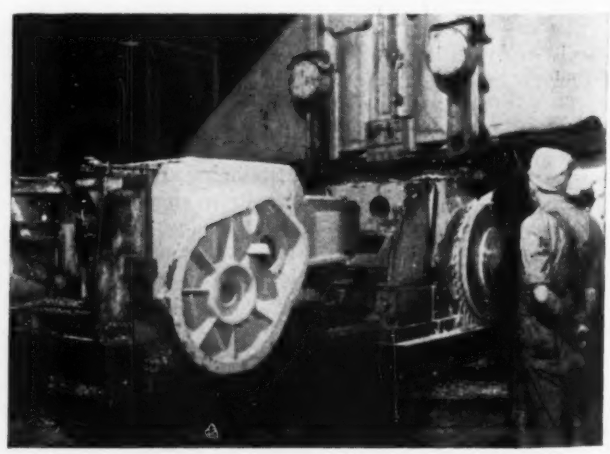


FIG. 8 MILLING SIDES AND TOP OF CLUTCH CASE

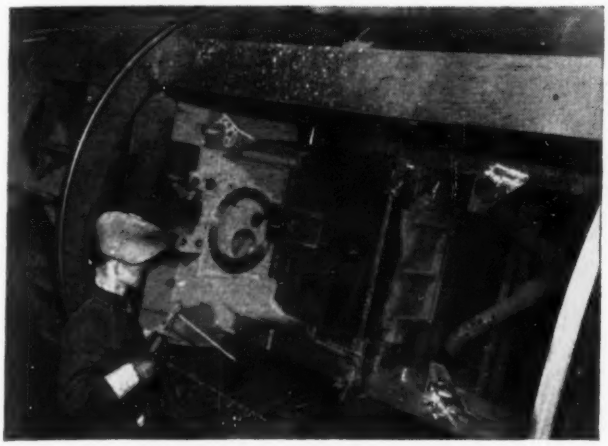


FIG. 9 WELDING FRAME ONTO CASE

inspection and machining. Fig. 8 shows the simultaneous milling of both sides and top of the case.

After the machining has been performed, the frame portion is welded onto the case, Fig. 9. Here a huge rotatable fixture holds the entire assembly for ready positioning by the welder. The addition of a few studs prepares the assembly for the tractor line.

Atomic Power Reactor

THE United States Atomic Energy Commission announced recently that it would acquire 4500 acres of land in Saratoga County, N. Y., as the location of an experimental atomic power plant for studies of the generation of electric power from nuclear energy.

The plant will be part of the facilities of the Knolls Atomic Power Laboratory, operated for the Commission by the General Electric Company at Schenectady. The Army Engineers will serve as agents of the Commission in the acquisition of the new site.

The new Knolls reactor is one of two now being designed especially for the study of high-temperature operation and the production of power. A different type of reactor but for a similar purpose is planned at the Commission's Argonne National Laboratory, Chicago, Ill. The design of both these reactors is directed to the problem of power generation by nuclear fission but by different methods, and both are expected to yield important data leading ultimately to the design of reactors which will produce power on a practical scale. They will also be valuable in solving some of the problems involved in "breeding" nuclear fuel.

In the operation of a nuclear reactor, the fuel consumed consists of fissionable material which produces heat for conversion into power. If the so-called breeding process works as scientists have reason to expect, the reactor will more than replenish the fuel consumed in operation. In addition to producing heat, a breeder-type reactor would convert nonfissionable uranium-238 into new fissionable matter.

Operation of the reactor will involve the production and handling of radioactive materials, carried out in a closed-cycle process that does not permit escape of radioactive liquids or dust. In designing of the Knolls reactor, G-E scientists and engineers have available the results of more than five years of experience of reactor operation carried on in various places in the United States. Experience in handling radioactive materials at many installations of AEC and nongovernmental institutions will be utilized on this project.

In authorizing acquisition of this site, the Commission has considered the dangers which might be created by a serious accident to the reactor. It is not possible to have a bomblike explosion. The rare type of accident which may create off-site hazards is in the nature of major damage to the reactor resulting from sabotage, severe earthquake, or the remote possibility of simultaneous failure of all safeguards and control mechanisms.

In view of the remoteness of these contingencies and the emphasis on safety measures to be built into the plant, the Commission and the Company have concluded, on the basis of careful studies by their respective staffs together with expert consultants, that the establishment of the plant on this site is fully justified.

Creep-Testing Machine

A NEW motor-driven screw-type creep-testing machine of 20,000 lb capacity, designed for short-time creep-rupture tests at high temperatures, with a minimum of operator attention, is announced by The Baldwin Locomotive Works, Testing Equipment Department, Philadelphia, Pa. The machine automatically maintains constant loads up to 100,000 psi on standard 0.505-in-diam specimens while temperatures are held constant up to 2200 F. Tests of this type may run for 10 to 400 hr.

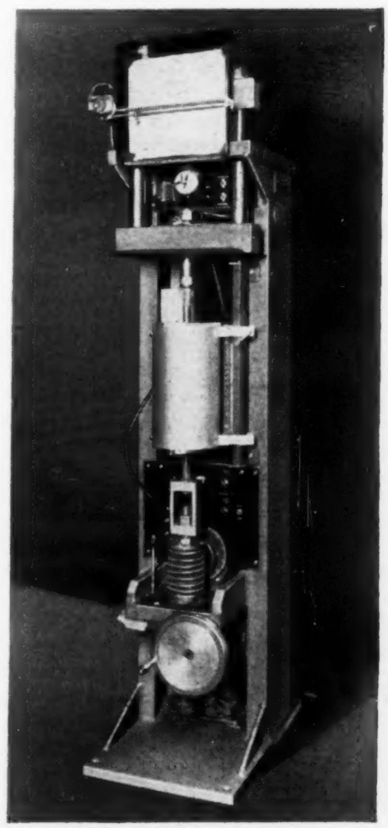


FIG. 10 CREEP-TESTING MACHINE

A feature of the machine is a flat 10 × 10-in. chart-recorder panel in front, with which no extensometer is required and no strain readings need be made. The elongation versus time

curve is automatically and accurately drawn on the chart from the start of the test until rupture occurs.

The recorder panel is driven vertically with the elongation of the specimen by the driving mechanism of the loading screw. The recorder pen is driven horizontally by a clock mechanism. Elongation is also indicated by a revolution counter which can be read directly in thousandths of an inch. It is operated by direct flexible shaft connection with the screw-jack drive shaft. Change gears in the elongation drive to the recorder give 1, 2, and 4 per cent elongations per inch.

The specimen is loaded below through gearing by means of a large electric-motor-driven screw having a stroke of approximately 4 in. The top end of the specimen is supported by a stiff heavy spring block on which the constant load is maintained by keeping a constant deflection. The deflection of the spring block is measured by a dial gage with an electrical contact. The electrical contact controls the motor that drives the screw. Thus a constant deflection is maintained in the spring block and a constant load is applied on the specimen during its elongation. When the specimen ruptures, the control circuit (of which the specimen is a part) is broken and both motor and clock are stopped.

The new machine can also be adapted readily to short-time tensile tests, constant strain-rate tests, or relaxation tests. The machine weighs approximately 1200 lb, is 7 ft high, and requires a 16 × 30-in. floor area.

Water Power

THE total capacity of water-power plants of the world at the end of 1947 was 86,900,000 hp, as determined by the Geological Survey, United States Department of the Interior, according to the *Journal of The Franklin Institute*, September, 1948. The total capacity for different years is shown in the following table:

Year (December)	Total capacity of water-power plants hp	Comparison with 1920, per cent increase
1920	23,000,000	..
1923	29,000,000	26
1926	33,000,000	43
1930	46,000,000	100
1934	55,000,000	139
1936	60,000,000	161
1938	63,900,000	178
1940	69,400,000	202
1941	71,600,000	211
1945	77,800,000	238
1947	86,900,000	278

The table shows an increase in installed capacity of water wheels from 23,000,000 hp in 1920 to 86,900,000 hp in 1947, a very large growth in the short period of 27 years. The increase appears to be continuing, taking the world as a whole. The shortage of fuels (oil, gas, and coal) and their increase in price make water power appear more desirable than ever. Although there was practically no increase in the United States during the last two years, in 1948 and the years immediately following there is indicated a possibility of an increase of about 1,000,000 hp a year. The Union of Soviet Socialist Republics is reported to be building many new plants, some of large capacity. Increased activity is reported also in Canada, France, Norway, Sweden, New Zealand, and India.

Total capacities of water-power plants for the different countries are obtained from consular agents, from information in the yearbooks published by foreign countries, from publications of the Department of Commerce, the Federal Power Commission, the International Union of Producers and Distributors of Electric Energy, and from other sources.

Because of the restrictions on the release of information and delays in publication of official yearbooks due to the war, accurate figures for recent years of the total capacity and of the construction and destruction of water-power plants in some European and Asiatic countries have not been made available. There is considerable conflicting information on some countries, but an effort has been made in these cases to select data from the most reliable sources. The figures of capacity of water wheels used for such countries may therefore be considered conservative and for others, such as Germany, Korea, and Taiwan, may be high. The Dnieper station in the USSR was completely destroyed, but three units of 100,000 hp each have been replaced. The figure 86,900,000 hp for the world at the end of 1947, should be reasonably correct.

Titanium

SMALL-SCALE manufacture of titanium metal, a new basic raw material for industrial development, has been announced by the du Pont Company, Wilmington, Del.

A pilot unit of 100 lb daily capacity is said to have been successfully placed in operation at the Newport, Del., plant of the Pigments Department. This, in so far as the company knows, is the first time ductile titanium metal has been produced for commercial exploration. The U. S. Bureau of Mines has been producing the metal for research purposes.

Titanium is a low-density, silver-white metal, between silver metal and stainless steel in color. In ductile form it possesses an excellent strength-weight ratio and good corrosion-resistant properties.

This means that in comparison with such common metals and alloys as iron, copper, silver, steel, and brass it is relatively light, and that for any given purpose it takes less of titanium than of any of the other commonly used metals to get the same strength. In its ductile form, as put out by Du Pont, it is readily workable and relatively pliable. Tests have shown that, without protection, its resistance to corrosion by salt water and atmosphere is excellent and that it withstands the effects of most chemicals better than most other structural metals.

More technically, these are some of its properties: atomic number, 22; atomic weight, 47.9; density, 4.5; melting point, about 3140 F; and boiling point, about 9210 F. Its yield strength in annealed form is about 70,000 psi; in cold-worked form, about 100,000 psi. Ultimate strength is 80,000 psi annealed and 110,000 psi cold-worked.

These facts describe the metal in its unalloyed form. All around, it compares approximately with 18-8 chromium-nickel stainless steel.

Reports of the Bureau of Mines and other organizations indicate that an early major use may be in high-speed airplanes and other forms of transportation. It may go into corrosion-resistant equipment and industrial machinery such as printing presses and textile equipment.

These reports also indicate that the properties of titanium are such that it may be used for reciprocating mechanical parts and in jet engines where heat and pressure are great.

Further research on the metal is now being carried on by other organizations, not only to determine its uses but also to determine its alloying possibilities. Meanwhile, du Pont technologists are in the midst of preliminary design work to expand production and improve the present manufacturing process.

Most titanium metal which has been available heretofore has been in powder form. Du Pont is producing it now in sponge form and will shortly be producing ingots weighing up to 100

lb. Running 99.5 per cent plus of purity, the metal is ductile and can be rolled and drawn readily. It has high resistance to breaking or pulling and has high strength against distortion.

Present price of the product is $5 per lb for quantities of 100 lb or more in sponge form. Ingot prices will be set later. The company will supply small samples without charge to industrial and university laboratories for testing.

Plastics Research

A RESEARCH program on the mechanical properties of plastics and the molecular changes induced by stress is depicted in a 16-mm sound and color film prepared by the Society of the Plastics Industry, Inc., and shown at a press preview recently in New York. The project is sponsored by the Plastic Materials Manufacturers Association and is being carried out in the laboratories of the Massachusetts Institute of Technology.

A large plastics testing machine shown in the film is capable of performing the exacting tests necessary and is one of the major aspects of the project. Greater than man-size, supported by two steel columns, it has a steel arm which pulls plastics to failure.

Servomechanisms enable the tester to subject materials to types of trials not hitherto feasible. In addition, the instantaneous recording of data, and other devices developed by the project made possible tests involving temperature, torsion, bending, and constant rates of load and movement, which heretofore could not be performed.

Another of the research tools shown in use is a turbidimeter, which permits a determination of the molecular composition of a plastic sample. The specimen is dissolved and placed in the path of a ray of light. Upon addition of a precipitant, the solution clouds up, according to the size and the changes in transmission of light occasioned by the molecular content.

Based on these tests, individual manufacturers will be able to make their own chemical analyses of plastics for information on their physical properties.

The benefit of this research to consumers is illustrated in the final portion of the film, through a rapid montage of prize-winning manufactured plastic products—the top entries in the 1948 Modern Plastics Competition.

This 16-mm sound and color film takes approximately 20 minutes to run and will be made available to groups that are interested.

Petroleum and Diesels

A REPORT entitled "Fuel Oil for Diesel Locomotives in Relation to the Supply of Petroleum," prepared by engineers of General Motors Research Laboratories and of the Electro-Motive Division, discusses the fuel-oil situation affecting home heating, automobile operation, and Diesel locomotives.

The report points out that if all of the 38,000 steam locomotives in operation on all U. S. railroads were abandoned today and completely replaced by Diesel locomotives the railroads would use less barrels of petroleum products than they now consume in the 6000 oil-burning steam locomotives alone.

It also points out that the 5000 Diesel locomotives in operation on American railroads today burn only one per cent of the total petroleum products consumption in the United States and if the railroads were completely dieselized they still would use less of the liquid-fuel supply than annually is burned in kerosene in lamps, small room heaters, and the like. Also, if all Diesel locomotives in the United States today were put out of service the national visible petroleum reserve would be lengthened only 45 days.

Oil companies are moving rapidly to offset the tightness in fuel-oil supply, both for home heating and Diesel railroad operation, by the provision of additional fuel-oil refining capacity so the 1947-1948 situation is only temporary, the report states.

Meanwhile a real attack upon the problem of lengthening the life of our visible petroleum reserves is under way. Forty per cent of the nation's petroleum-products consumption or two million barrels per day (as compared with railroad Diesel consumption of 50,000 barrels a day) now is in gasoline, chiefly used in highway vehicles. The report discloses that General Motors has successfully operated test automobiles hundreds of thousands of miles with new engines that give a 20 per cent gasoline saving (see MECHANICAL ENGINEERING, October, 1948, p. 822). Furthermore, developments have progressed to the point where, accorbing to the report, "engines capable of 40 per cent fuel savings will ultimately become available."

It is also stated in the report that if the miles per gallon obtained in automobiles and trucks were increased by only one mile, three times as many barrels of petroleum could be saved as is used by all of the Diesel locomotives in operation today.

In case of war the Diesel locomotive is a great internal national asset, the report declares. For example: The railroads connecting Chicago with the Pacific Coast, by substituting only a few hundred Diesel freight locomotive units for coal-fired steam locomotives during World War II, handled as much additional tonnage as would have been handled had a whole new transcontinental railroad been built.

In conclusion, the report states that to insist that the railroads invest their money in coal-fired steam locomotives which were recognized as obsolete ten years ago in the light of the foregoing conditions, is like asking the automobile companies, because of the shortage of steel and fuel, to return to the manufacture of carriages and wagons.

Synchrocyclotron Pole Tips

A RADICAL departure in the design of pole tips for the magnet of the new 400-million-volt synchrocyclotron now being built by Carnegie Institute of Technology, Pittsburgh, Pa., will enable Tech scientists to operate this machine at a magnetic field beyond that obtained in other cyclotrons, it was announced recently.

The Carnegie atom smasher is said to be unlike any other atom smasher in existence in that it is more compact and is the only one with pole-tip faces having "hills and valleys" machined into them.

Other cyclotrons have a series of "steps" in the pole tip profiles, but C.I.T.'s "shims," as the pole tips are called, will have, in addition to the steps, deep concentric grooves near the edge of the 141.65-in. pole tips. As a result of the new design the C.I.T. cyclotron has extended the useful radius to 96.5 per cent of the actual shim radius.

By comparison, other cyclotrons are able to maintain high fields only to about 85 to 90 per cent of their respective shim radii.

A definite improvement over existing cyclotrons, the C.I.T. atom smasher will not suffer a loss in energy of the particles, it produces despite its compactness. Capable of producing 400-million-volt particles, the cyclotron will weigh only 1500 tons. Other existing or contemplated machines in the same energy class require from 2000 to 4000 tons of steel.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Hydraulics

Repairs Hydro Adjustable Blade Turbines by Welding, by Joel B. Justin, Philadelphia, Pa., and Ed T. Davis, Indiana Michigan Electric Company, Mishawaka, Ind. 1948 ASME Fall Meeting paper No. **48—F-1** (mimeographed).

Approximately five tons of welding rod have been used in repairing cavitation of 646 sq ft of the adjustable-blade turbines of the Kanawha Valley Power Company hydro plants at London, Marmet, and Winfield. These major repairs, requiring new blade inserts and stainless clad plates, have been carried on during the low-water periods over the past four years and recently have been completed.

All these plants are located on the Kanawha River near Charleston, W. Va., at Government navigation dams and operated under contract and leases with the Federal Power Commission. Marmet and London are identical plants, each having two adjustable-blade turbines rated at 7600 hp and 7250 hp and one fixed-blade turbine rated at 6600 hp. The Winfield plant has three adjustable-blade turbines, all rated at 9200 hp. All nine units operate at 90 rpm.

The adjustable-blade units at the three plants are of two different manufactures and are 169 in. and 172 in. in diameter. The units at Winfield are the same as the ones at the other plants except for higher rating due to increased head. Many of these units operate more than 8000 hr per year. These units actually operated at higher loads than the manufacturer's rated capacity and this fact, no doubt, contributed to increased pitting of the runner blades.

Cavitation was noticed on the blades of the adjustable units within the first year of operation. In 1937 one unit at Marmet was repaired by conventional chipping, cladding with stainless 18-8, and grinding. At this time 52.6 sq ft were covered with 752 lb of stainless-clad rod and 400 lb of mild-steel rod. During the ensuing years cavitation progressed, but due to power exigencies caused by war and the war preparedness program, it was not advisable to have the equipment out of service for long periods of time.

The first unit was repaired in the conventional manner, chipped to solid metal, built up with welding metal, and covered with two layers of stainless steel and ground to the original contour. The welders were imported from another affiliated company. Chipping, grinding, and miscellaneous work was done by the company's own forces. Columbium-stabilized 25-12 stainless rod was used in order to keep carbon pickup from the parent metal to a minimum. The heaviest grinding tools were used and afforded no particular difficulty for the men to operate as they devised their own supports and holding devices. A complete tight scaffold was constructed below the blades and an exhaust blower with ducts was used to get rid of the welding fumes and gases. This unit had a total of 62.7 sq ft of surface which was rebuilt and clad with 875 lb of mild-steel and 1050 lb of stainless-steel rod.

A schedule was set up to repair the other five units which were all cavitated severely. It was decided to schedule these repairs over the dry-month periods of the following three years.

Although somewhat different methods were used on some of the units, in general, the same procedure was followed throughout. The units at Winfield were cavitated to a greater extent as to area and severity than the ones at London and Marmet. In many cases the periphery of the blades was entirely gone with holes through the trailing ends. There were 95 sq ft of this surface to be repaired on the blades of each unit. The cast throat rings were cavitated to a depth of $^3/_4$ in. and in places there were holes through the $1^1/_4$-in. steel casting. There was a band two feet wide around the $169^3/_8$-in-diam throat ring or 87 sq ft which was repaired, making a total of 185 sq ft to be repaired on each unit.

A description of these repairs is given in detail for each phase including blade repairs, throat-ring repairs, and shaft-sleeve repairs. The blade repairs required the use of precast inserts and welding these to the blades. The throat ring was first machined by using the unit as a boring mill and then welding stainless clad plates to the throat ring preforming them to the original contour. Shaft sleeves were repaired by metal spray and machining in place.

How to Order ASME Papers

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NOTE: ASME Publications and advance copies of ASME papers are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th St., New York, N. Y. ASME Transactions and *Journal of Applied Mechanics* are also on file in ASME depositories maintained in 245 libraries in the United States, including libraries of all ASME Student Branch institutions.

Petroleum

Construction of Katy Gas Cycling Plant, by W. T. Robertson, Mem. ASME, and H. N. Stamper, Humble Oil & Refining Company, Houston, Tex. 1948 ASME Fall Meeting paper No. **48—F-3** (mimeographed).

Gas cycling may be defined as an operation of producing gas from a gas reservoir, processing through a product extraction plant for recovery of desired liquefiable hydrocarbon fractions, and the compression of residue gas remaining after product extraction to reservoir pressure and injection wells into gas-pro-

duction reservoir for pressure maintenance and maximum recovery of original reservoir gas. In the majority of gas fields, it has been found that the recoverable hydrocarbons in the reservoir exist as a gas at reservoir pressure and temperature. If a reservoir is produced to the extent that there is a decline in reservoir pressure, a certain quantity of recoverable hydrocarbons will condense and be lost in the producing sand. By cycling operations, the reservoir pressure is maintained due to the return of plant residue gas to the producing formation. The pressure maintenance, therefore, prevents the loss of products which would otherwise occur due to pressure decline.

The Katy Gas Cycling Plant is one of the largest of its type in operation. It is designed to process 458 million cubic feet of gas per day from 33 producing wells, recovering 80 per cent of the potential butanes and practically all of the pentane and heavier hydrocarbons. Approximately 400 million cubic feet of wet gas per day enter the high-pressure absorbers, operating at 1800 psi. The absorber residue gas, around 388 million feet per day, is returned by gas-engine compressor units to the 13 injection wells. The remaining plant capacity is utilized in the processing of gas for delivery to two sales transmission systems.

Extraction and fractionating facilities are installed to permit optimum recovery of the desired hydrocarbon fractions, and segregation into various products for marketing. Under normal operations, the plant processes an average of 458 million cubic feet of reservoir gas per day from which the following products are recovered: methane-ethane-propane mixture, commercial propane, commercial isobutane, commercial normal butane, gasoline (72 octane to 91 octane aviation fuel), and heavy naphtha.

The field system, high-pressure gas system within the plant, condensate system, distillation system, steam and power system, and safety and alarm system are discussed.

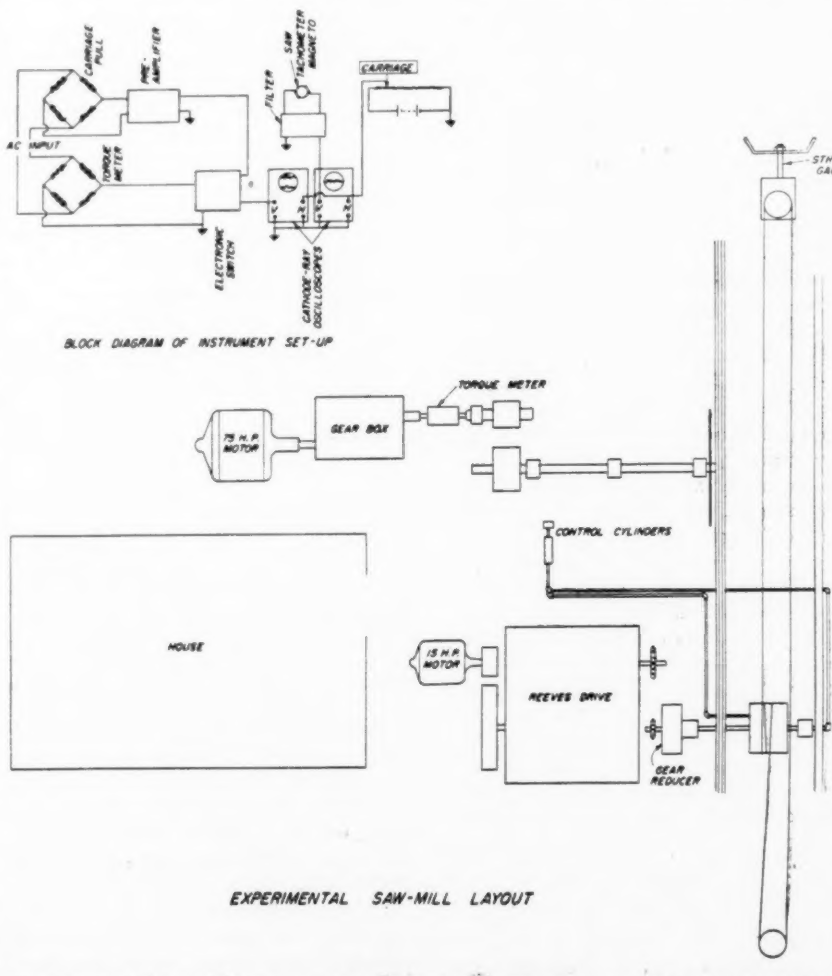
Wood Industries

Investigation of Energy Requirements for Inserted-Point Circular Headsaws, by C. J. Telford and L. H. Reineke, U. S. Department of Agriculture, Madison, Wis. 1948 ASME Fall Meeting paper No. **48—F-5** (mimeographed).

The objective of this investigation, which is still under way at the U. S. Forest Products Laboratory, is to explore the effect of saw-tooth form and operating speeds of saw and carriage on the efficient use of power in ripping logs under conditions normally encountered in sawmills. The specific questions to be answered are: How does power consumption vary with (1) chip thickness, (2) depth of cut, (3) kerf width, (4) hook angle, (5) saw diameter, (6) wood density, (7) type of cutting (climb cutting contrasted with normal cutting), (8) temperature (frozen versus unfrozen timber), and (9) what gullet space is required per unit of wood removed?

The forces associated with the variations of tool factors were first investigated and thereafter a selected combination was used uniformly on a series of species other than Douglas fir for the purpose of attempting a correlation with the more complete findings registered for Douglas fir and to determine further if significant correlation can be found between force requirements and a physical property, particularly specific gravity. If this correlation can be established, the force requirement for any commercial species can be predicted from the average densities tabulated in various publications of the Forest Products Laboratory. The species sawed were Douglas fir, ash, basswood, cottonwood, cherry, elm, hickory, black oak, soft maple, and white oak.

The milling and recording equipment was arranged for flexibility, so that the material could be fed to the saw at selected constant rates between 30 and 300 fpm, and a selective constant-speed saw drive gave speeds of 300, 450, and 600 rpm. Recording equipment was sensitive to load changes of less than 3 per cent. The saw is driven by a 75-hp electric motor through a 3-speed gearbox and a V-belt drive. The essential recording shipment comprised strain gages attached to the anchor bolt of the sheave carrying the cable pulling the carriage, and a torque meter of the strain-gage type between the gearbox and the drive pulley to the driven pulley on the saw mandrel. A slide-wire potentiometer was connected to the carriage to indicate its position, and saw speed was indicated by an electric tachometer on the saw mandrel. These indication instruments were connected to two 5-in. oscilloscopes placed



SCHEMATIC LAYOUT OF SAWMILL AND INSTRUMENT SHELTER, AND BLOCK DIAGRAM OF INSTRUMENTATION

so that a recording camera included both screens. The sawmill was a modified standard make of the medium-weight portable class (approximately 4000 lb).

The sawing tests described in the paper were the initial tests made with this equipment and sufficient time has not been available for their adequate analyses and correlation of findings. This paper therefore only presents the technique used, with comments on some of the actual observations of saw behavior. It was, however, possible to make a rough analysis of one phase, the gullet space required for removal of a unit quantity of wood. Two points of importance were revealed. The first is the necessity for a gullet design which will be self-clearing when operating at maximum capacity, regardless of saw speed. The second point is that gullet capacity varies, in terms of solid material, with the species being cut. This may be due to differences in packing with different densities, or to greater escape from the gullet of fibrous sawdust in the softer species.

Gas Turbines

Mobile Gas-Turbine Power Plants and Locomotives, by Walter Giger, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1948 ASME Fall Meeting paper No. **48—F-4** (mimeographed).

This paper is essentially the same paper presented at the 1947 ASME Annual Meeting (see MECHANICAL ENGINEERING, May, 1948, page 457, digest of paper No. 47—A-134), except for the addition of a section on a proposed 4000-hp oil-burning gas-turbine locomotive of a somewhat novel design. The 4000-hp locomotive consists of a cab containing the power plant, two engineer's cabs, all necessary auxiliaries, some oil and water tanks, steam boiler, and two main and guiding truck groups. The main trucks each contain four driving axles, one traction motor, and the gear drives for the axles, and individual axle drives. The individual axle drive proposed is of a design containing no springs and needing no lubrication. It does not affect the springing of the locomotive, and each axle can move up and down freely within the design limits of the journal box guides and spring deflection. Each driving axle is equipped with a worm-

INDIVIDUAL AXLE DRIVE

drive reduction-gear box, consisting of a large gear wheel mounted on a hollow quill shaft which surrounds the axle, and a multithread worm. The four gearboxes are rigidly mounted in the main truck frame, that is, above the springs, and are therefore not subjected to any blows or the continuous movement of the axles with respect to the truck frame. The drive shafts of these gearboxes are arranged in the longitudinal center line of the truck. All gear boxes are connected by means of flexible couplings. The driving motor of each main truck frame is rigidly mounted on it, directly above the guiding truck, which is arranged in the well-known fashion at the outside end of each main truck. A short air duct with a flexible air connection connects the motor and the blower.

The total weight of the locomotive has been estimated to be about 560,000 lb. The load on drivers amounts to about $8 \times 50{,}000 = 400{,}000$ lb, whereas the guiding truck axles carry about 40,000 each, or 160,000 lb total. The maximum speed of the locmotive is 100 mph; tractive effort at starting, 122,000 lb up to about 7.5 mph; tractive effort, one hour, 62,000 lb at 20.4 mph.; tractive effort, continuous, 51,000 lb at 24.8 mph.

Aviation

A Method for the Analysis of Complex Activities and Its Application to the Job of the Arctic Aerial Navigator, by J. M. Christensen, Aero Medical Laboratory, Wright-Patterson Air Force Base, Dayton, Ohio. 1948 ASME Aviation Division Meeting paper No. **48—AV-2** (mimeographed).

This report describes a method employed in gathering activity data under rather unusual and difficult circumstances. The chief merits of the method are simplicity and flexibility of application.

The data were gathered in an effort to obtain answers to three questions with regard to Arctic aerial navigation:

1 What new equipment or what changes in present equipment will result in the greatest improvement of the Arctic navigator's efficiency?

2 What is the optimal layout of the equipment in the Arctic navigator's workplace with regard to convenience, importance, frequency of use, and reduction of fatigue?

3 What minimum crew requirements will insure satisfactory navigation of present aircraft in the Arctic, and how can the number safely be reduced in the future?

The findings fall into the following general categories:

1 Poor arrangement of the equipment in the workplace is making it impossible for the Arctic navigator to get maximum results from present equipment.

2 More automatic equipment is needed before the number of crew members can be reduced safely.

3 Greater inherent accuracy is required in some of the present navigation equipment.

4 Some navigational techniques should be simplified.

All these points are interrelated. It is true that more automatic equipment and a more functional arrangement of the equipment will decrease the number of required navigators (the latter causes no increase in weight, and therein lies its greatest advantage). However, disregarding any humanitarian considerations (only because they are so difficult to assess), if the equipment used in place of a crew member weighs more than the crew member and his present equipment, it is a poor investment unless the equipment can do the job significantly better. As an aid in determining the value of automatic equipment, a simple ratio has been formulated which may be used as a rough guide in determining the value of new equipment from the standpoint of its weight.

The sampling method of activity analysis described in this report is being extended to include the duties of other aircrew personnel. The method might be employed by airlines or agencies such as the Civil Aeronautics Administration to obtain objective data regarding problems such as the optimal number of aircrew in commercial transport aircraft. The method is being modified and extended and will be used to analyze complex systems such as ground radar and communication centers. The method is usable whenever it is desirable to know the time an individual devotes to various aspects of a job and the general sequence of such operations. The results of this specific study should be useful to commercial agencies contemplating polar air routes.

Automatic Control of Turbojet Engines, by Clifford S. Cody, Westinghouse Electric Corporation, Lester, Pa. 1948 ASME Aviation Division Meeting paper No. **48—AV-3** (mimeographed).

From the military pilot's standpoint, a single cockpit control lever should be all that is required to operate the turbojet engine over its full range of thrust, along

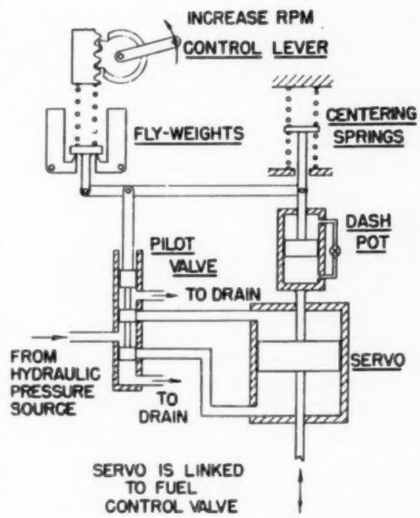
a line of optimum practical economy, and within its safe limitations for turbine rpm, temperature, and burner operation. Moreover, the control-lever sensitivity must be such that predetermined thrust settings may be selected without difficulty.

In order to retain the operational simplicity of single-lever power control of the engine in the face of increasing stringent operating requirements for the turbojet engine, it has become necessary for the turbojet-engine manufacturers to expend a major part of their development effort toward perfection of automatic engine-control elements. During the early development of the turbojet engine, it was reasonable to expect that greater emphasis would be placed on the design of the basic engine than upon the controls because it was considered that simple manual controls would be adequate; however, since it has been generally realized that control performance has lagged basic engine development, a concentrated effort has been made to provide automatic engine controls which permit the full range of engine performance to be realized without detracting the military pilot's attention from his primary combat duties. As this automatic-control development has progressed, flight experience has dictated more and more stringent operating requirements as represented by closer speed regulation, faster acceleration, and increased service life. These requirements have been combined to make this development a difficult one, particularly as it has been desired that these improvements be promptly incorporated in engines already in operation in the field and in those coming off the production line.

The prime object of this paper is to acquaint the control designer with the general requirements for control of turbojet engines so that he can better anticipate the problems which will arise while developing controls for specific turbojet applications. Although the information presented is of a very basic nature, it is presupposed that the reader is generally familiar with the fundamental principles of jet propulsion and the functional arrangements of turbojet-engine components.

The body of this paper is presented in four sections: Fuel Controls, Acceleration Controls, Mechanical Design Requirements, and Variable-Area Exhaust Nozzle Controls.

Based on engine operational experience and engineering design studies of control problems, the following requirements are considered the primary requisites for a turbojet-engine power control in order to meet the needs of military aviation and



SCHEMATIC ARRANGEMENT OF AN ISOCHRONOUS FUEL CONTROL GOVERNOR FOR TURBOJET ENGINE

realize the full operational performance of the engine: (1) Control to hold the selected thrust stable within specified limits for each flight speed and altitude; (2) basic control design based on direct measurements rather than on scheduling; (3) single-lever control of the engine to give a linear relationship between thrust and throttle movement; (4) control to permit engine acceleration to be as rapid as the temperature and aerodynamic limitations of the engine permit; (5) fast response rate to provide for rapid changes in the operating loads on the engine; (6) controlling elements to be designed to give a low fuel pressure drop in order to minimize fuel pumping loads; (7) control to operate satisfactorily on contaminated fuel.

Thrust Augmentation as Applied to the Turbojet Engine, by Edward Woll, General Electric Company, West Lynn, Mass. 1948 ASME Annual Aviation Conference, paper No. **48—AV-4** (mimeographed).

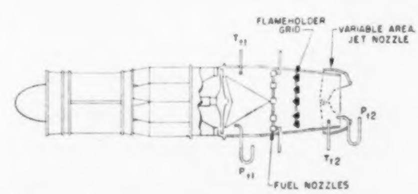
In aircraft driven by turbojet engines it is found that even though ample thrust is available for cruise and high-speed operation, thrust is not adequate to give the short take-off run that is usually associated with the propeller-driven airplane.

Many schemes to augment the thrust of the turbojet engine have been proposed or developed. Each has its own limitations in either the possible degree of augmentation, in increased fuel and liquid consumption, in the feasibility of applying to an airplane the equipment by which augmentation is obtained, or in the range of usefulness. Of the methods proposed only two, water injection and reheat cycle of "tailpipe burning," are finding application at present as being practicable and airworthy. Only these are discussed in this paper.

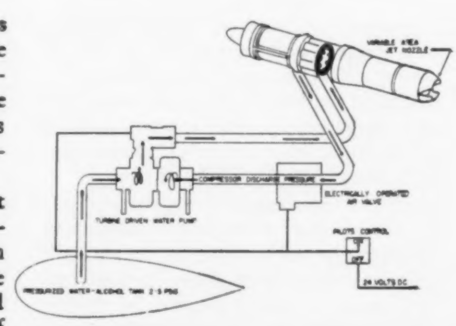
It is pointed out that the water-injection method of augmentation, although limited in the amount of additional thrust that can be obtained and with this additional thrust obtained at very high specific liquid consumptions, only negligibly increases the weight of the propulsion unit; and the installation in no way affects the performance of the power plant when augmentation is not used.

The most serious disadvantage of the reheat method of augmentation is the effect of the reheat burner on power-plant performance when the reheat burner is not in operation. This effect and the increased weight of the propulsion unit plus that of a large-diameter cooling shroud and larger fuselage are of a magnitude to rule out augmentation by reheat in certain airplane applications. Even though the total specific fuel consumption is high, augmentation with reheat is practical in flight in view of the much improved performance obtainable. Use of the same fuel in the reheat burner as well as in the combustion system of the engine is a decided advantage, whereas with water injection the water-alcohol mixture can be used only for one purpose.

In summary, augmentation methods will be used when additional thrust is required for short periods only and as long as the additional thrust can be ob-



EXHAUST REHEAT BURNER INSTALLED ON A TURBOJET ENGINE



TURBOJET WATER-INJECTION SYSTEM

tained at a higher thrust-weight ratio than can be delivered by the main engine itself. Augmentation methods will also be resorted to for special missions that call for additional performance from an airplane that is already in service.

Applied Mechanics

Impact of a Mass on a Damped Elastically Supported Beam, by W. H. Hoppmann, 2nd, Johns Hopkins University, Baltimore, Md. 1947 ASME Annual Meeting paper No. **47—A-144** (in type; published in the *Journal of Applied Mechanics*, June, 1948, pp. 125–136).

In this paper a study is made of the problem of the central impact of a mass on a simply supported beam on an elastic foundation with considerations of internal and external damping. The differential equation for the forced vibration of the beam is developed. It is solved for the case in which the force is a function of time and is concentrated at the center of the beam. Formulas are obtained for the deflections. An expression is developed for the coefficient of restitution which is essential in determining the deflections and the strains. Criteria are devised for determining the cases in which the beam may be considered as a single-degree-of-freedom system when damping and an elastic foundation are considered. The importance of these criteria is discussed. A numerical example illustrating the theory developed in the paper is worked out in detail. Results of computations for several numerical solutions are given in tabular form.

Contact Stresses in the Rolling of Metals—I, by C. W. MacGregor, Mem. ASME, and R. B. Palme, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Applied Mechanics Meeting paper No. **48—APM-22** (in type; published in the *Journal of Applied Mechanics*, Sept., 1948, p. 297).

Special equipment is described which was designed and constructed to investigate the distributions of the normal pressures and the longitudinal and transverse shearing stresses along the arc of contact during the rolling of metals between plain cylindrical rolls. While the paper is restricted to a description of this apparatus, it is planned to utilize it in studying the effects of many of the important rolling variables both on the contact stresses and on the resulting mechanical properties of the rolled product. Experimental results will be presented in a later paper.

THE following papers are to be presented at the ASME Annual Meeting, Nov. 28–Dec. 3, 1948, New York, N. Y. Advance copies of these papers are now available and may be purchased from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

Flow Through a Pipe With a Porous Wall, by F. C. W. Olson, Ohio State University, Columbus, Ohio. 1948 ASME Annual Meeting paper No. **48—A-1** (in type; to be published in the *Journal of Applied Mechanics*).

The problem of the flow through a long unbranched pipe with uniformly spaced orifices presents some undesirable mathematical difficulties. These can be avoided by solving the related problem of the flow through a pipe with a porous wall. The differential equations for pressure drop and flow are derived and the relation between them is indicated. A solution for the flow is obtained in terms of elliptic functions in such form that numerical results can be obtained readily from existing tables.

Investigation of the Variation of Point Unit Heat-Transfer Coefficients for Laminar Flow Over an Inclined Flat Plate, by R. M. Drake, Jr., University of California, Berkeley, Calif. 1948 ASME Annual Meeting paper No. **48—A-2** (in type; to be published in the *Journal of Applied Mechanics*).

Many applications of heat-transfer phenomena by forced convection require a knowledge of heat transfer from simple geometric bodies like the flat plate. Investigations of the flat plate have been limited, in general, to studies of isothermal plates of 0-deg angle of incidence and in laminar flow. The amount of data concerning investigations on turbulent flow, nonisothermal plates or inclined plates is quite small. It is the intent of this paper to provide information on the heat transfer from a nonisothermal, inclined flat plate in laminar flow. It is shown herein that forced-convection heat-transfer data for an inclined nonisothermal flat plate with a constant specific rate of heat flow can be correlated and represented by an equation of the type

$$\frac{Nu_x}{\sqrt{Re_L}} = C\left(\frac{x}{L}\right)^n \ldots\ldots [1]$$

for laminar flow. It is further shown that this equation is similar in slope to the theoretical equation of the type

$$\frac{Nu_x}{\sqrt{Re_L}} = C_2\left(\frac{x}{L}\right)^{\frac{m+1}{2}} \ldots\ldots [2]$$

for an isothermal plate in laminar flow, but is larger by 30 per cent in absolute value. This variance can be partly explained by an analysis of the behavior of a nonisothermal plate as opposed to an isothermal one, but this analysis leaves much to be desired, so that the full explanation is at present unknown.

On the Impact Behavior of a Material With a Yield Point, by Merit P. White, Mem. ASME, University of Massachusetts, Amherst, Mass. 1948 ASME Annual Meeting paper No. **48—A-3** (in type; to be published in the *Journal of Applied Mechanics*).

An analysis of longitudinal impact tests that were made by Drs. D. S. Clark and P. E. Duwez at the California Institute of Technology on an iron and a steel with definite yield points is described. From this analysis is deduced the probable nature of the dynamic stress-strain relations for such materials. These appear to differ greatly from the static stress-strain relations, unlike the case for materials without yield points. As pointed out by Duwez and Clark, the upper yield stress for undeformed material is several times as great under impact as the static yield stress. The present analysis indicates that under impact, the material with a definite yield point is made harder at a given deformation, and ruptures at a higher (engineering) stress and smaller strain than when loaded statically. The critical impact velocity, defined as that at which nearly instantaneous failure occurs in tension is discussed, and the factors upon which it depends are given.

Theory of the Damped Dynamic Vibration Absorber for Inertial Disturbances, by J. E. Brock, Jun. ASME, Washington University, St. Louis, Mo. 1948 ASME Annual Meeting paper No. **48—A-4** (in type; to be published in the *Journal of Applied Mechanics*).

If a mass which is mounted flexibly is set into forced vibrations by a harmonic force having an amplitude which does not vary with frequency, a damped dynamic vibration absorber may be designed to reduce the vibrations to some preassigned amplitude, regardless of the range over which the frequency of the disturbing force may vary. The theory of this type of vibration absorber, together with valuable discussion, has been given in a paper by Ormondroyd and Den Hartog, and is readily available in Den Hartog's text on mechanical vibrations. In this paper the author presents a similar

analysis for the case in which the amplitude of the disturbing force varies as the square of its frequency. For lack of a better name, this will be referred to as the case of "inertial disturbance." Such cases are of considerable practical importance. For example, disturbances due to unbalance in rotating machinery are of this type. In some cases, such as those in which the unbalance varies with temperature, it may be impractical or impossible to secure perfect or nearly perfect balance, and a vibration absorber, designed on the basis of the analysis to be presented, may offer a suitable remedy. A practical example of this nature is given. The analysis follows a pattern similar to that given by Den Hartog, but enough of the details are different to warrant an extended treatment.

A Study of the Supersonic Axial-Flow Compressor, by W. A. Loeb, De Laval Steam Turbine Company, Trenton, N. J. 1948 ASME Annual Meeting paper No. **48—A-5** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents a summary of the basic principles of the supersonic compressor and an analytical study of the types of this compressor most likely to prove successful. This study assumes rather idealized conditions, ignoring such variables as radial effects and flow irregularities. Hence the results are not intended as design criteria. They should, however, give a fair guide to what may be expected of the various cases considered; their outstanding limitations, their range of operation, and their performance expectations. Conclusions are that good pressure ratios with high efficiencies may be attained; that the compressor having a normal shock in the stator is superior to that having a normal shock in the rotor; and that the largest restriction on this normal-shock-in-stator compressor is the Mach-number limitation in the rotor.

Note on the Bending of Circular Plates of Variable Thickness, by H. D. Conway, Jun. ASME, Cornell University, Ithaca, N. Y. 1948 ASME Annual Meeting paper No. **48—A-6** (in type; to be published in the *Journal of Applied Mechanics*).

In a recent paper ("The Bending of Symmetrically Loaded Circular Plates of Variable Thickness," by H. D. Conway, *Journal of Applied Mechanics*, Trans. ASME, vol. 70, March, 1948, pp. 1–6) a solution was given to the problem of a symmetrically loaded circular plate with a central hole, the thickness of the plate at any section being proportional to the distance of the section from the center of the plate. A very simple solution can be obtained for another variation of thickness of which the foregoing is a special case.

Fatigue Under Combined Pulsating Stresses, by H. Majors, Jr., Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass., B. D. Mills, Jr., Mem. ASME, University of Washington, Seattle, Wash., and C. W. MacGregor, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Annual Meeting paper No. **48—A-7** (in type; to be published in the *Journal of Applied Mechanics*).

A special combined stress pulsator is described which was used to subject thin-walled cylindrical tubes to various ratios of combined (in phase) pulsating stresses. The material investigated was annealed SAE-1020 steel. Stress ratios in both the (+, +) and the (+, —) quadrants were applied. In addition, tension tests and uniaxial completely reversed rotating bending fatigue tests were made in the axial and tangential directions to study the anisotropy of the material. The combined stress-fatigue tests agreed best with the distortion-energy theory of strength.

On the Stability of Plates Reinforced by Ribs, J. M. Klitchieff, Belgrade University, Belgrade, Yugoslavia. 1948 ASME Annual Meeting paper No. **48—A-8** (in type; to be published in the *Journal of Applied Mechanics*).

The stability of plates reinforced by a large number of transverse ribs and subjected to compressive loading is considered. An expression is developed which gives directly the required rigidity of the ribs by transformation of the expression for critical compressive forces previously developed by S. Timoshenko. Use of trigonometric series is made to calculate effective width of plate. A numerical example is given to compare the results of the method with Lloyd's Rules (1931–1932) used in cargo-ship design.

A Strain-Energy Expression for Thin Elastic Shells, by H. L. Langhaar, Mem. ASME, University of Illinois, Urbana, Ill. 1948 ASME Annual Meeting paper No. **48—A-9** (in type; to be published in the *Journal of Applied Mechanics*).

A derivation is given for the strain energy of an isotropic elastic shell whose radii of curvature are sufficiently large that strains may be assumed to vary linearly throughout the thickness. The work of Love has been the only previous general investigation which expresses the strain energy in terms of the displacements of the middle surface. The effects of the tangential displacements upon the energy due to bending are found to differ appreciably from Love's results in the first-order terms. As in the classical large-deflection theory of flat plates, quadratic terms in the derivatives of the normal deflection are retained in the strain tensor, but quadratic terms which involve the tangential displacements are neglected. Special forms of the general energy expression derived in this paper are given for shells in the shapes of flat plates, circular cylinders, elliptical cylinders, ellipsoids of revolution, and spheres. These applications, as well as certain intuitive observations, provide checks on the theory.

On the Design of Large Elevator Platforms, by F. Hymans, Mem. ASME, Otis Elevator Company, Larchmont, N. Y. 1948 ASME Annual Meeting paper No. **48—A-10** (in type; to be published in the *Journal of Applied Mechanics*).

Large elevator platforms are, in effect, complex systems of a comparatively few main framing members, coupled by a large number of stringers which support the flooring. As set forth in the paper, and as is qualitatively well known, a load placed on one of the main members is not carried by that member alone. Deflections, impressed by the loaded member on the stringers, induce forces which cause neighboring members to share in the support of the load. However, means to evaluate the distribution of the load with reasonable accuracy, important as it is for a rational design of the platform with the lightest structural shapes, hitherto have not been available. To furnish these is the purpose of the paper. With the aid of two assumptions, and the introduction of certain auxiliary forces, the problem is quickly reduced to the case of a beam, subject to a force at an arbitrary point, supported at its ends, and resting on a flexible foundation.

General Features of Plastic-Elastic Problems as Exemplified by Some Particular Solutions, By Rodney Hill, British Iron and Steel Research Association, Cavendish Laboratory, Cambridge, England. 1948 ASME Annual Meeting paper No. **48—A-13** (in type; to be published in the *Journal of Applied Mechanics*).

New complete solutions based upon the Reuss equations are obtained for

various plastic-elastic problems. These include the expansion of a spherical shell and of a cylindrical hole in an infinite medium. The solutions are used to exemplify certain features common to all plastic-elastic problems, with a view to introducing valid approximations in more complex cases.

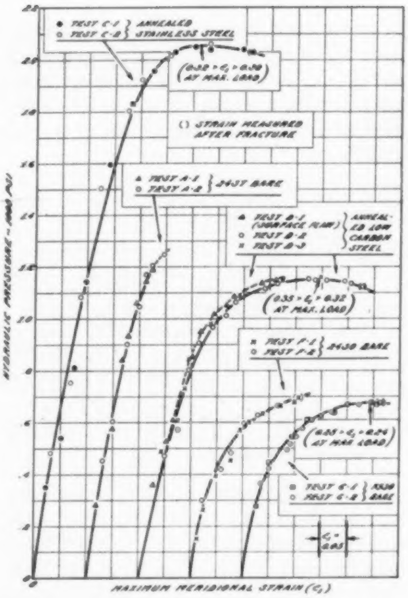
Fracture of Gray-Cast-Iron Tubes Under Biaxial Stresses, by R. C. Grassi, Mem. ASME, and I. Cornet, University of California, Berkeley, Calif. 1948 ASME Annual Meeting paper No. **48—A-15** (in type; to be published in the *Journal of Applied Mechanics*).

The fracture of gray-cast-iron thin-wall tubes was investigated, for various ratios of axial to tangential stress ranging from pure tension to pure compression, yielding data for some stress ratios not previously reported. Analysis of the results reveals that the present theories of fracture do not account completely for the data obtained, thus indicating the need for further investigations of similar materials.

Metals Engineering

Strength and Failure Characteristics of Metal Membranes in Circular Bulging, by W. F. Brown, Jr., NACA, Cleveland, Ohio, and F. C. Thompson, Allegheny Ludlum Steel Corporation, Dunkirk, N. Y. To be presented at the 1948 ASME Annual Meeting, New York, N. Y., Nov. 28–Dec. 3, 1948. Paper No. **48—A-11** (in type; to be published in Trans. ASME).

Circular hydraulic bulges were formed from a group of materials having widely varying strain-hardening rates. The complete development of the shapes and strain distributions was determined experimentally, and the stress and radius of curvature at the pole were calculated as a function of the maximum strain. An analysis of the data revealed that strain gradients and therefore the bulge heights were influenced by the stress-strain characteristics of the metal. It was also found that the bulge contour was closely approximated by a sphere only at strains in the vicinity of the instability strain. Instability was exhibited by all materials having a sufficient ductility at strains varying from $\epsilon_3 = -0.47$ for 75S-O to $\epsilon_3 = -0.64$ for annealed low-carbon steel. The phenomenon of instability was related to both the development of the shape and the strain distribution. The previously reported differential equation for instability in a circular bulge was found to yield strains which agreed with the maximum load strain and the instability



PRESSURE-STRAIN CURVES FOR CIRCULAR BULGING OF VARIOUS MATERIALS

strains derived from the analysis of the shape and strain distributions. These instability strains were not found to be simply related to the necking strains in uniaxial tension. The height and maximum strains (forming limits) obtainable in bulging were found to be greatly reduced by the presence of surface flaws or a large grain size.

Silicone Rubber

Silicone Rubber—New Properties for Design Engineers, by G. S. Irby, Jr., Wyman Goss, and J. J. Pyle, General Electric Company, Pittsfield, Mass. 1947 ASME Annual Meeting paper No. **47—A-126** (in type; published in Trans. ASME, October, 1948, p. 831).

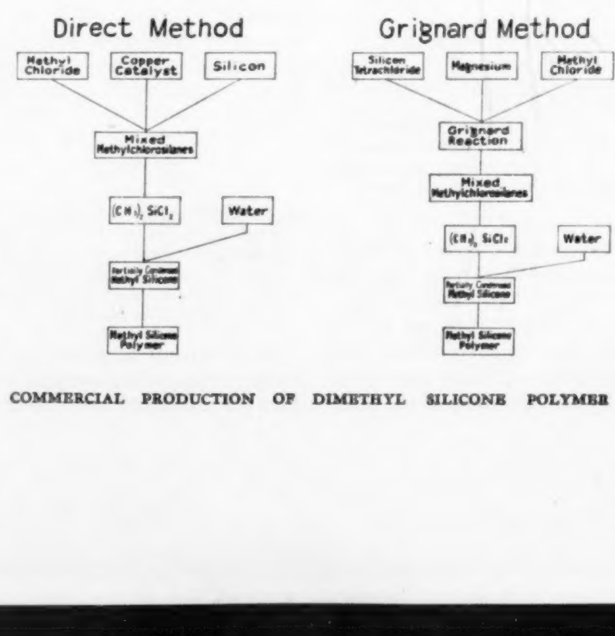
As a result of rapid developments in the field of organosilicon chemistry during the last few years, a whole new class of high-polymeric materials has been made available to product and design engineers. This group includes such products as silicone rubber, oils, resins, greases, and water-repellant films. The members of the silicone family naturally vary as to properties and potential applications. However, they all offer an outstanding characteristic, namely, thermal stability from —70 F to +500 F.

Silicone rubber, the elastomeric member of this family, shows its temperature stability by not only retaining its flexibility, resiliency, and surface hardness over this entire temperature range but also by resistance to long periods of heat-aging. The availability of an elastomer with these heat-resistant properties immediately suggests new design possibilities where elastic materials are needed in equipment operating at elevated temperatures. However, mistaken conceptions of this material will arise if it is merely substituted for conventional rubbers in existing designs. The properties of silicone rubber do not match those of natural or synthetic rubber at room temperature. On the other hand, at operating temperatures of —70 F or at +500 F, the properties of other elastomers generally fall short of silicone rubber.

The physical, chemical, and electrical properties of this material, as affected by high and low temperatures, have been studied. The results of this study, together with fabrication techniques and proved applications, are compared to show where silicone rubber may be of best use to the design engineer.

As to where the properties of silicone rubber may be put to use, the field of gaskets and packings immediately suggests itself. In the design of seals, engineers are looking with greater favor on molded elastomeric materials.

It is pointed out that silicone rubber is in no way a substitute material or just another elastomer. Its properties of thermal stability offer to the materials



COMMERCIAL PRODUCTION OF DIMETHYL SILICONE POLYMER

engineer a brand new product and a new range of temperature conditions where elasticity can be obtained.

Its flexibility range of from —70 F to 500 F, its resistance to oxidation, excellent heat-aging, low compression set, and good electrical properties are factors which can be put to use in a variety of applications.

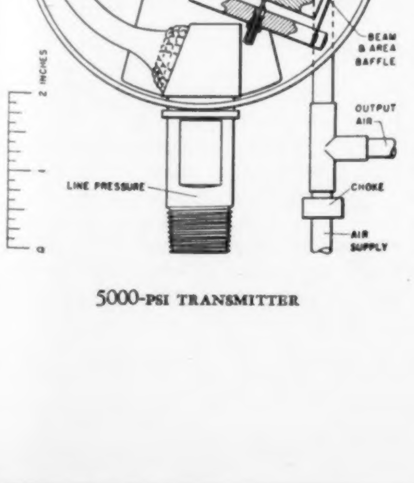
Industrial Instruments

The Use of Bourdon Tubes in Pneumatic Pressure Transmitters, by O. C. Brewster, Litchfield, Conn. 1948 ASME Industrial Instruments and Regulators Division Meeting paper No. **48—IIRD-1** (mimeographed).

The application of Bourdon tubes as the pressure elements in pneumatic pressure transmitters of the force-balance type is described. The pressure-versus-force characteristics of restrained Bourdon tubes result in a major reduction in the loading of the various elements of the instrument compared with those employing diaphragms or bellows.

The traditional use of a Bourdon tube is the measurement of the deflection of its unloaded free end to give an accurate indication of the internal pressure applied to the tude. The use proposed in this paper is to restrict the normally free end to substantially no deflection and to utilize the force applied to accomplish this as a force accurately proportional to the applied pressure.

A transmitter for a line pressure range of from 0 to 5000 psi was designed and built, using a Bourdon tube as the primary pressure element and an area baffle as the balancing unit.



5000-PSI TRANSMITTER

The Bourdon tube is a welded steel tube from a standard make of pressure gage rated at 5000 lb with a $4^1/_2$-in. dial. The entire instrument is housed within the regular gage case.

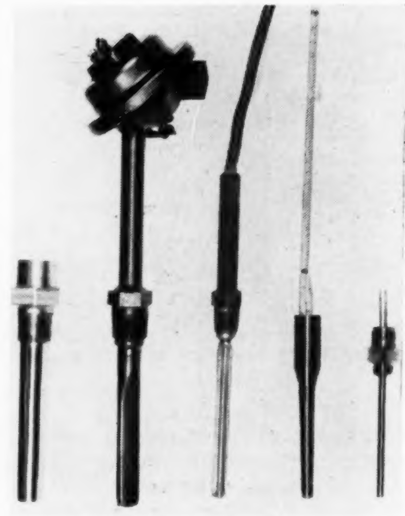
Air is supplied to the instrument at around 30 psi through a $^1/_4$-in-OD tube provided with a choke orifice of $^1/_{64}$ in. diam and output air is led away through $^1/_4$-in-OD tubing to the receiving pressure gage. Consumption of air is at the rate of about 0.16 cmf free air with zero line pressure and about 0.13 cfm with full line pressure when supplied at 30 psig pressure.

Because of the relatively small mass of the moving parts of this instrument compared with the internal forces involved, operation is remarkably independent of vibration and position and the instrument may be subjected to severe shock or completely inverted while in operation with only minor deviations in output air pressure.

Response Characteristics of Thermometer Elements, by A. J. Hornfeck, Bailey Meter Company, Cleveland, Ohio. 1948 ASME Industrial Instruments and Regulators Division Meeting paper No.**48—IIRD-2** (in type; to be published in Trans. ASME).

Speed of response of the thermometer element is an important factor in the accurate measurement and control of temperature for industrial processes. This paper discusses the significance of the time constant as a basis of comparison of elements and shows quantitatively by means of data and curves the effects of varying the design factors such as socket size, materials, and internal element structure. The relation between the heat-transfer rate from the surrounding medium to the socket wall and the element response is shown by response data for a number of designs tested in air and water. Methods are given for determining the temperature versus time response curves of elements in a medium whose temperature is changing suddenly, uniformly, and sinusoidally as a function of time.

On the basis of the test results and analysis presented in this paper, it may be concluded that the equivalent time constant is a satisfactory basis for comparing the speed of response of totally immersed thermometer elements. A single time constant defines quite accurately the response of the bare or elementary thermometer and, less accurately but generally to a good approximation, the response of the socket protected thermometer. There is believed to be no justification for the use of some other factor such as the time required for 90 or 99 per cent of the temperature change to take place, particularly since these values of time have no direct relation to the physical constants of the thermometer and because they are relatively difficult to obtain experimentally.

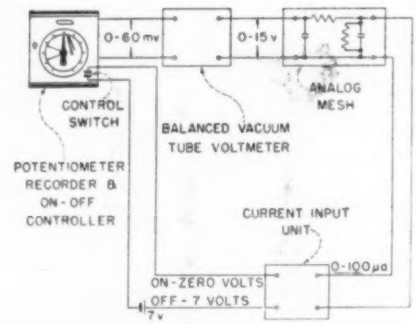


SEVERAL COMMERCIAL-TYPE RESISTANT THERMOMETER SOCKET ASSEMBLIES

The data and analysis show that only the bare or elementary thermometer can be compared under all conditions on the basis of a time constant obtained by a single test in a specific medium. It is not generally reliable to compare the socket-encased element response for all applications on the basis of a single test, as, for example, in water, since the equivalent time constant or over-all response is determined by three individual time constants. It is possible and often the case that one element may be faster in water but slower in some other medium such as air. However, it is often possible to calculate the response of the socket-protected element for various conditions on the data obtained by a single test.

Laboratory Analogs for Electric Furnaces, by S. P. Higgins and R. M. Hutchinson, Brown Instrument Company, Philadelphia, Pa. 1948 ASME Industrial Instruments and Regulators Division Meeting paper No. **48—IIRD-3** (mimeographed).

In the study of automatic control methods for processes, it is often desirable to compare the operation of several controllers on the same process. The use of analogs provides simulated processes in the laboratory for such tests. Thus, it is possible to perform prefield test studies on the operation of preliminary models in a location where adjust-



SCHEMATIC DIAGRAM OF PROCESS ANALOG BOARD

ments are easily made and any malfunctioning or process disturbances will not cause serious consequences.

This work involves the use of general analogs, having the characteristics of certain class of processes, to study the affects of controller span, sensitivity, and measurement dead time on control obtained.

A process which can be adequately described by a suitable differential equation can be represented by an analog. Since most controlled processes are fairly complex, developing analogs from test data appears to be preferable to setting up differential equations. Also, an analog offers the possibility of introducing certain types of nonlinearities which may be present in a process, but cannot be described by the differential equations.

Since the same type of on-off electric controller may be used for control of small laboratory furnaces or control of large heat-treating furnaces, it is often desirable to study specific types of applications. This paper is concerned with the development of analogs for specific units to which on-off control is applied.

Heating Values of Fuels

Definitions of Heats of Combustion of a Fuel and Current Methods for Their Determination, by E. F. Fiock, R. S. Jessup, and F. W. Ruegg, National Bureau of Standards, Washington, D. C. 1947 ASME Annual Meeting paper No. **47—A-123** (in type; published in Trans ASME, October, 1948, p. 811).

Definitions are given for high and low heats of combustion, both at constant pressure and at constant volume, and the relations connecting the four quantities thus defined are discussed. Apparatus in current use for measuring heats of combustion of solid, liquid, and gaseous fuels, the corrections which must be applied, and the procedure for calculating the results are described. A brief résumé is given of the present prospect for calculating the heats of combustion of mixed gases from analytical data.

Uses of High- and Low-Heat Values, by A. G. Christie, Fellow and Honorary Mem. ASME, Johns Hopkins University, Baltimore, Md. 1947 ASME Annual Meeting paper No. **47—A-123** (in type; published in Trans. ASME, October, 1948, p. 819).

This paper gives current definitions of thermal efficiency and current usage of observed fuel heat values, and consumption test data for the evaluation of thermal efficiencies reported for (*a*) steam and (*b*) internal-combustion power plants. The author summarizes uses of high- and low-heat values in American practice. Commercial practice as well as theoretical considerations have influenced the choice of high- or low-heat values for the determination of thermal performances.

Energy-Temperature Relations in the Combustion of Fuels in Gas Turbines, by R. V. Kleinschmidt, Mem. ASME, Consulting Engineer, Stoneham, Mass. 1947 ASME Annual Meeting paper No. **47—A-123** (in type; published in Trans. ASME, October, 1948, p. 821).

In this paper, the author discusses procedures for evaluating energy, temperature, and pressure relations based on precise knowledge of thermodynamic properties of the gases resulting from the combustion of fuel in thermal devices, including gas turbines. The problem of computing thermal efficiency and fuel required to cause a given temperature rise in the working fluid of a gas turbine is discussed.

Petroleum Mechanical Engineering

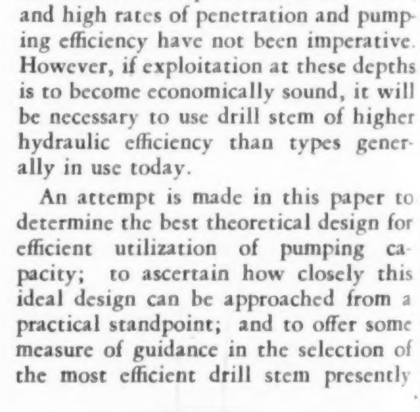
Tool Joint Design and Mud Flow in Drilling, by Stanley C. Moore, Hughes Tool Company, Houston, Tex. 1948 ASME Petroleum Division Conference paper No. **48—PET-1** (mimeographed).

A large portion of the horsepower-hours consumed by a rotary rig is expended in pumping the drilling mud down the drill stem and up the well-bore annulus. In this paper, some factors that influence the hydraulic efficiency of the circulation system are discussed. Principal factors considered are tool-joint design and pipe sizes. Other factors which must be considered in drill-stem design are space allowance for fishing, elevator-shoulder requirements, effect on bottom hole pressure, and annular return velocity. The hydraulic efficiencies of some popular constructions are evaluated and comparisons made with theoretical designs. Tables and charts have been prepared to aid in selecting types for best operating economy.

From the standpoint of hydraulic efficiency only, the optimum diameters of both the drill pipe and tool joint can be easily approximated for specified hole sizes. There are, however, practical considerations to be taken into account, such as operational problems, tool-joint design, drill-pipe sizes available, and the fact that many operators must use one string of drill stem for several hole sizes. Generally, it appears that present pumping losses through drill stem and annulus could be cut in half, even from a practical standpoint. Drill-stem losses ordinarily consume 50 per cent to 80 per cent of the pumping energy. As wells become deeper this proportion becomes greater.

Drilling to depths below 15,000 ft has been on an exploration basis to date, and high rates of penetration and pumping efficiency have not been imperative. However, if exploitation at these depths is to become economically sound, it will be necessary to use drill stem of higher hydraulic efficiency than types generally in use today.

An attempt is made in this paper to determine the best theoretical design for efficient utilization of pumping capacity; to ascertain how closely this ideal design can be approached from a practical standpoint; and to offer some measure of guidance in the selection of the most efficient drill stem presently



TYPICAL TOOL JOINT PIN AND BOX CONNECTION; CRITICALLY STRESSED SECTIONS ARE INDICATED

available. Only the threaded and shouldered pin and box connection is considered. The connection which must be made between the pipe and tool joint is not important from a hydraulics standpoint because with modern methods the sections required are less than those needed for the pin and box.

Drill Pipe Corrosion Problems, by G. L. Corrigan and A. E. Schlemmer, Oklahoma A.&M. College, Stillwater, Okla. 1948 ASME Petroleum Division Conference paper No. **48—PET-2** (mimeographed).

It is emphasized that a drill stem is under constant attack by its environment when stored, standing in the derrick, or when in use. Many of the factors tend to cancel each other, but in the case of some, the combination aggravates the activity.

The best means of combating pure chemical solution of the iron and the resulting corrosion is to watch carefully for changes in the pH of the fluid and to maintain fluid velocities and rotational speeds which will tend to minimize turbulence in the flow column. The use of nonelectrolytic drilling fluids, such as the oils, resins, and others, and the addition of pH-modifying agents such as the chromates will all aid in the battle.

In the fight against electrochemical corrosion any treatment which will render the surface of the stem more nearly homogeneous and free from mechanical irregularities will act as a control. The treatments include wire brushing, sandblasting, shotpeening, and coatings of either the neutral or anodic protection type. The use of chromates as suggested in the prevention of chemical action also may act as an electrochemical corrosion inhibitor through the deposition of chromium from the chromium salts.

The use of neutrally coated stems with short sections of uncoated stem is extremely dangerous due to the concentrated anodic nature of the unprotected areas.

In electrolytic solutions, any broken areas in mill scale surfaces may promote the formation of anodic points.

Work has been done which indicates that the differential velocities of the internal and external flow of fluids is sufficient to create an electromotive force with the high-velocity side being anodic and the low-velocity side being cathodic. Such action, over a period of time, could cause disastrous results from corrosion of the inside surface of the stem. Other than by the use of nonelectrolytic drilling fluids, any such action should be lessened by the use of wall-building fluids which prevent the development of cavitation and the resulting decrease in external velocities.

Stressed areas have been found to become anodic with respect to unstressed areas. By largely eliminating the stresses the possibility of corrosion of this type should be materially decreased.

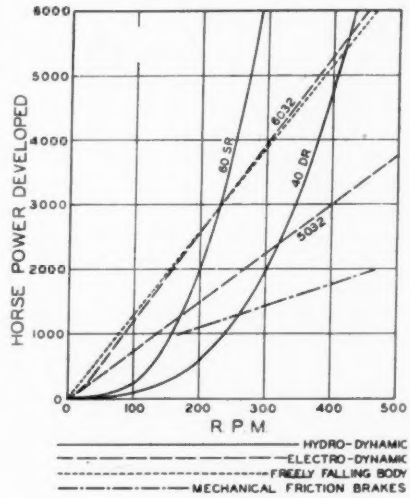
The Operating Characteristics and Requirements of Drawworks Brake Equipment, by R. Griffin De La Mater, The Parkersburg Rig & Reel Company, Parkersburg, W. Va. 1948 ASME Petroleum Division Conference paper No. **48—PET-3** (mimeographed).

In this paper an analysis is made of the operating characteristics, capacity, and limitations of the mechanical friction brakes, and of the hydraulic and electric types of supplemental dynamic brakes used on drawworks. Consideration is then given to the relative advantages and disadvantages of various methods of drawworks operation while running in the drill pipe. The speed-load characteristics of the drawworks, for a preferred method of operation, are then compared with the speed-capacity characteristics of the several available brake systems. Consideration is also given to the requirements of the driving means for supplemental dynamic brakes.

Up to the time that the majority of oil wells did not exceed 3000 to 4000 ft in depth the design and operation of the brake equipment of drilling hoists did not present any serious problems. However, with the drilling of wells to depths beyond 4000 ft it was found that, due to their inherent limitations, mechanical friction brakes were becoming increasingly inadequate for either safe or economical operation.

In 1932 the hydrodynamic brake was introduced as an adjunct to the mechanical friction brakes of drawworks and rapidly became recognized, not only as a solution to the braking problem when drilling to depths of 5000 ft or more but also as a distinct advantage when drilling to lesser depths. The brake system comprising the combination of mechanical brakes with some type of supplemental dynamic type of "energy dissipator" has now been practically universally adopted for all but the lightest of drawworks.

Because of the great depth to which wells are now being drilled, as well as the present great interest in speedier, more efficient, and more economical drilling operations at all depths, it is essential that the characteristics and limita-



COMPARATIVE CHARACTERISTIC CURVES OF THE ELECTRODYNAMIC AND HYDRODYNAMIC SUPPLEMENTAL ENERGY DISSIPATORS AND OF MECHANICAL FRICTION BRAKES

tions of the now available brakes for drawworks be examined in the light of the service to which they are now subjected. Such is the purpose of this paper.

ASME Transactions for October, 1948

THE October, 1948, issue of the Transactions of the ASME contains the following papers:

Development of Cleavage Fractures in Mild Steels, by A. B. Bagsar (Paper No. 47—A-75)

Definitions of Heats of Combustion of a Fuel and Current Methods for Their Determination, by E. F. Fiock, R. S. Jessup, and F. W. Ruegg (Paper No. 47—A-123)

Uses of High- and Low-Heat Values, by A. G. Christie (Paper No. 47—A-123)

Energy-Temperature Relations in the Combustion of Fuels in Gas Turbines, by R. V. Kleinschmidt (Paper No. 47—A-123)

Symposium on Heating Value of Fuels—Discussion

Silicone Rubber—New Properties for Design Engineers, by G. S. Irby, Jr., Wyman Goss, and J. J. Pyle (Paper No. 47—A-126)

Development of a High-Speed Lathe for Machining Aluminum, by R. L. Templin (Paper No. 47—A-41)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

"Economic Curiosa"

To the Editor:

Some time ago, the writer submitted to the Society a paper entitled, "Economic Curiosa," the purpose being to point out to engineers the absurdities from which much of our misleading economic thinking and writing derives. That paper was not considered an appropriate subject for the Society publications. Nevertheless, with some amusement the writer has observed the continuing use of these curiosities by authors whose writings find acceptance by the publications committee.

It is not surprising perhaps that the evident confusion in our economic activities continues to confound itself. In his "Quantitative Thinking in Economics," the Swedish writer Gustav Cassel discussed the "loose and dim concepts, falsely stated problems, confused reasonings, representations not in touch with reality" of which economic theory is largely composed. Yet it is on such confusion of first principles and fundamental notions that the recent paper by C. S. Wyand,[1] seems to depend. If we continue to so think about our industrial economy and accordingly seek to control it, inevitably we shall find ourselves out of touch with reality.

Let me point out but a few of the quantitative fallacies in this paper. He observes that we now create "45 per cent of the world's annual total of goods and services." If this be not a mere metaphor, then it is an obvious quantitative and arithmetical absurdity. How he proposes to measure a turbogenerator and a performance of Macbeth, good or bad, in terms of the same unit is beyond my poor power of imagination. There is no quantitative total of the goods produced by, say, the electrical industry, much less a world total. Possibly Mr. Wyand thinks in terms of those index numbers of production denoted by Ivar Fredholm as "hermaphrodite arithmetic monsters devoid of sense." J. M. Keynes called them "concoctions," and Ludwig v. Mises described them as the "dubious results of mere playing with numbers."

[1] "American Industry—Democracy's Ace in the Hole," by C. S. Wyand, Mechanical Engineering, vol. 70, Aug., 1948, pp. 663-665.

Regarding this matter, in addressing the editor of the *American Statistical Associatoon Journal*, a critic of an article by the writer stated "that index numbers are wrong in *principle* (italics by the critic himself) is well recognized by competent economists today though doubtless not sufficiently recognized." If that be the case, the literature indicates that the list of competent economists must be very limited.

Later in his paper, Mr. Wyand proposes some measure of the total world production of war munitions, of which he states we manufactured more than 50 per cent. To determine this percentage to any reasonable approximation, he must have some unit and method of measurement in mind. However, he does not give the unit in terms of which this production of assorted items is so measured that the 50 per cent has some sort of explicit significance.

It may amuse the reader to know that during the late war the writer's attention was drawn to some statisticians in the employ of the War Department who were adding together such items as numbers of khaki shirts and numbers of M-2 tanks in computing a total average of war materials in process, in storage, in transit and delivered at the beach heads! Believe it or not I have copies of the records of these numerical gymnastics in my possession. This absurdity was intended as a guide for G.H.Q.! Possibly Mr. Wyand's 50 per cent refers to some similar arithmetic nonsense.

Mr. Wyand mentions "the output per man-hour" as increasing "at an average annual rate in excess of 3 per cent for the 30 years, 1909 to 1939." Since this is expressed in per cent output per man-hour, presumably there is some unit of such output regardless of the kind and unit of the heterogeneous collection of goods produced. Perhaps Mr. Wyand can describe this over-all unit and tell us how to apply it. Or, again he may be misled by the breeders of those arithmetic monsters called index numbers. Obviously, there is no general measure of output per man-hour. In fact, the man-hour, considered aside from what the man does during that hour, is a questionable unit for measure.

It is well to draw attention to the obvious lack of reliability of a chronological average such as the foregoing extending over 30 years, during which lapse of time the essential economic conditions changed materially. In any case such an average implies that production during the 30 years was approximately constant. This because the average is represented by a straight-line trend parallel to the time axis. The deviations from such a trend are many, large, and variable in distribution.

Again Mr. Wyand writes of a rise in the purchasing power of a dollar. Francis A. Walker wrote that the word measure should be associated with the term purchasing power, if at all, only in a consciously metaphorical sense. Yet, Mr. Wyand tells us this rise in purchasing power exceeded one third. Thereby he implies that there is a workable unit of purchasing power apart from the dollar! Well, Jacob Viner wrote of purchasing power as "a treacherous term" and Lipson wrote of it as "illusive, the vague generalizations about which are more misleading than illuminating." One begins to wonder where Mr. Wyand learned his economics. There is, of course, no measure of purchasing power.

But Mr. Wyand mentions "real purchasing power" in connection with the matter of wages. What is this real purchasing power in terms of which wages rose 45 per cent? How is it computed and in terms of what unit? According to the published records, real purchasing power is the result of playing with the inverse of that dubious arithmetic monster, the price-index number. The result is indeed a hermaphrodite. It seems to be on a par with that law enacted by a misled Kentucky legislature that no goods should be marketed in Kentucky at more than their "real value." In declaring that law to be invalid, the late Justice O. W. Holmes remarked that it implied "a price in an imaginary world" where also belong real purchasing power, real wages, and all the other "loose and dim concepts" of economic theory.

So long as people continue to think and write in such terms, having no contact with economic reality, so long will we fail to understand and operate safely the economic universe we have been so busy at putting together.

Since the economic and monetary controls now in use are based upon such absurdities as just discussed, it is little to be wondered that at every turn we seem to be faced with a situation beyond our ability to master.

BASSETT JONES.[2]

REPLY BY C. S. WYAND[3]

Apparently Mr. Jones has no objection to the gist of the writer's paper; at least he raised none in the foregoing comment. Neither does he refute the approximate validity of the data cited. Rather, his letter takes the form of a philippic against statistical devices in general, and index numbers in particular.

This is neither the time nor the place to discuss the scientific worth of statistics. Nonetheless, it is difficult to understand the violence of Mr. Jones' agitation. I know of no responsible person who believes that index numbers or other statistical measures are precisely accurate mirrors of reality. Indeed a significant part of statistical method is concerned with the measurement of statistical error. But, at the same time, I know of no responsible scientist who does not feel that statistical approximations, when properly made and interpreted, are better than no quantitative measures at all.

Since Mr. Jones is not in accord, and feels impelled to warn the members of the Society against falling into statistical ways, I can only urge their careful attention to his argument.

It's the Little Things That Count

COMMENT BY WALTER W. SOROKA[4]

The author is to be commended for his readable and useful paper on the title subject.[5] He has shown with interesting and concrete illustrations how design must be co-ordinated with materials and processes in order to produce the most economical product under prevailing conditions. Such illustrations provide a fruitful source of instruction for embryo engineers.

It is true indeed that little things in design may cause grave difficulties on the production line. The author is concerned with technical details in this paper. Important as these are, there are equally important little things in labor relations which may and do cause production difficulties. The author himself is in an excellent position to know just how troublesome and yet impalpable such things can be. It would appear to the writer that a discussion of the "little things that count" in keeping production rolling smoothly could well include the human problems generated by the close and continuous association of people and work.

A little unattended grievance, a little unrealized favoritism, a little undetected injustice, all fancied or otherwise, may rankle and fester and assume exaggerated proportions in the close-knit daily relations of production workers, or even in engineering offices.

Although the engineer is trained to control technical details, he generally finds that with time he becomes more and more involved in enlisting a willing "most" from a working force. Usually he finds himself ill-equipped to handle the human factors as effectively as he does the technical factors. More published material on down-to-earth human relations as experienced by industrial executives in all grades should do much to help prepare the young engineer for the future.

[2] New York, N. Y. Mem. ASME.

[3] Assistant to the President, The Pennsylvania State College, State College, Pa.

[4] Associate Professor of Engineering Design, College of Engineering, University of California, Berkeley, Calif.

[5] "It's the Little Things That Count," by A. F. Murray, MECHANICAL ENGINEERING, vol. 70, June, 1948, pp. 519–522.

"Democracy and Progress"

TO THE EDITOR:

Prof. Ralph E. Freeman is to be complimented on his review[6] of Prof. David McCord Wright's new book "Democracy and Progress." The writer has read this book very carefully and feels that it appeals particularly to the engineer's sense of balance.

The engineer knows that all design is a compromise, whether it be of an airplane, a tank, or a battleship. Only the theorist with no production experience will make the impractical designs of the young college student. The engineer will be particularly pleased with Professor Wright's treatment of the question of monopoly. We should all take to heart his statement: "The totalitarian pressures of modern society are so great that only by the most intense effort of all men of good will can democratic collapse be avoided." Again, he states: "Their mutual checks and balances increasingly drain away the energy which has gone into the constructive change upon which rising living standards depend, and the executive is more and more reduced to a mere manager obliged to follow the line of least resistance—the sabotage of invention."

This brings the writer to one of his "pet peeves"—the present inept reporting of business statistics in our daily press. He is convinced that the competent writer, like the capable teacher, is he who is able to present his information in a form that can be understood by his readers. Unless this be borne in mind, the press is merely furnishing ammunition to the detractors of our way of life.

When the press reports that the profits of a certain corporation have increased one thousand per cent, they may have increased from one tenth of one per cent to one per cent. The one-thousand per cent increase has an alarming ring to the workman.

Likewise we say the earnings of a certain industry have increased one hundred millions in the last quarter without any qualification as to investment or other circumstances involved. Is the unintelligent man to be blamed when he thinks he is getting the short end of the deal?

Many of our members are in a position to see that something is done about this. To the mechanical engineer this is a vital subject. He should read Professor Wright's excellent book.

CARROLL D. BILLMYER.[7]

[6] "In Defense of Competition," by R. E. Freeman, MECHANICAL ENGINEERING, vol. 70, August, 1948, p. 683.

Errata to 1948 Addenda to ASME Unfired Pressure Vessel Code

ON page 353 of the 1948 Addenda to the Unfired Pressure Vessel Code, the revision of Par. U-13(c) is incorrect. All persons holding copies of the addenda should correct this paragraph to read as follows:

"(c) Fusion-welded vessels over 1 in. in thickness constructed of steel conforming to Specifications SA-202 Grade A, SA-203, SA-204, SA-212, SA-225, SA-299, SA-301, and SA-302 shall conform to the provisions of Par. U-68. Where vessels constructed of these steels do not exceed 1 in. in thickness at any welded joint, the provisions of Par. U-69 may be followed provided:

(1) Vessels constructed of steel conforming to Specification SA-212 shall be subject to the stress-relieving requirement of Par. U-76(b);

(2) Vessels constructed of high tensile steels conforming to Specifications SA-202 Grade A, SA-203, SA-204, SA-225, SA-299, and SA-301 shall be stress-relieved when the thickness is 0.58 in. and over;

(3) Vessels constructed of high tensile steel conforming to Specifications SA-302 shall be stress-relieved in all thicknesses."

[7] Associate Professor of Mechanical Engineering, Rhode Island State College, Kingston, R. I. Mem. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Diesel Fuel Oils—Production Characteristics and Combustion

DIESEL FUEL OILS—PRODUCTION, CHARACTERISTICS, AND COMBUSTION. (Lectures delivered at 19th ASME National Oil & Gas Power Conference, May 20, 1947. Foreword by W. L. H. Doyle, Chairman, Committee on Lectures.) ASME, 29 West 39th Street, New York 18, N. Y., 1948. Paper, 6 × 9 in., tables, bibliography, 52 figs., 128 pp., $3.50.

REVIEWED BY EDGAR J. KATES[1]

THIS concise book is the outcome of the initial effort by the Oil and Gas Power Division, ASME, to render a novel kind of service to engineers interested in Diesel engines.

Practicing engineers, busy with their everyday tasks, now and then realize that they are failing to keep pace with some of the more fundamental developments in fields that are closely related to their own. Ordinarily it is not easy to inform one's self on scientific and engineering progress in related fields, because of the huge amount of reading which would be required.

Believing that this need on the part of many engineers could best be satisfied by arranging a one-day course of thoroughly prepared lectures by recognized authorities, the Executive Committee of the Oil and Gas Power Division decided to present annually such a series of lectures on a day just preceding each national meeting of the Division.

Because recent developments in petroleum technology pointed to a significant evolution in the nature of Diesel-engine fuels, the topic chosen for the first series of three lectures was "Diesel Fuel Oils—Production, Characteristics, and Combustion."

These lectures, which are here made available in permanent form, were presented in Cleveland on May 20, 1947, by the following specialists in their respective fields:

"Production of Diesel Fuel Oils," by C. A. Rehbein, research and development department, Shell Oil Company.

"Physical and Chemical Characteristics of Diesel Fuel Oils," by R. D. Pinkerton, research and development department, Sinclair Refining Company.

[1] Consulting Engineer, Diesel Specialist. ASME Director at Large, 1945-1949.

"Combustion of Diesel Fuel Oils," by Martin A. Elliott, chemist, Bureau of Mines, Department of the Interior.

Each lecture was followed by an enlightening discussion, which is included in the book. A single comprehensive index applying to all three lectures is an unusual but helpful feature.

It is gratifying to note how well the authors succeeded in choosing their material and the form of presentation to meet the needs of the busy engineer whose college days are all but forgotten. For instance, Mr. Rehbein starts off with a refresher on the chemist's shorthand for describing the structure of hydrocarbon molecules and proceeds to cite examples of the typical structures of paraffins, naphthenes, and aromatics. Then follows a clear explanation of the theory of distillation and the method by which separation is actually accomplished in a fractionating column. From this start one is lead by easy steps to the complexity of a modern oil refinery, with its topping units, vacuum flashers, catalytic crackers, and gas-recovery units.

One next learns how the pitch from the flashing unit and the heavy gas oil from the catalytic cracker are further processed in a thermal cracking unit to make the blend suitable for sale as residual fuels such as Bunker C. Also how a different type of thermal cracking unit is used to improve the quality of the low-grade naphtha from the topping unit.

Alkylation becomes less of a mystery when we see that this is a process which uses a sulphuric acid catalyst at low temperature to build up the size of the molecule to a point where it fits into the gasoline boiling range. This process was responsible during the war for producing the high quality components of aviation gasoline.

Other elements of a modern oil refinery, their purpose and method of operation, are described clearly. Tables list typical yields of the several products of each piece of equipment; the overall picture is presented in a refinery yield balance which shows how the individual components are blended to meet product specifications and sales commitments.

After a brief discussion of American developments in producing synthetic fuels and shale oil, the lecture concludes with an enlightening outline of how oil-refinery operations are continually being altered to meet changes in the relative demands and prices for the various petroleum products.

Mr. Pinkerton devotes himself to the characteristics of Diesel fuel oils. He reviews the chemical compounds that are present in Diesel fuels and gives their physical properties, showing how these control the characteristics of the composite fuel mixture. To this reviewer, it seems that Mr. Pinkerton tells the practicing engineer all he needs to know about the basic components of petroleum fuels, viz. paraffins, olefins, naphthenes, and aromatics. This is followed by a discussion of so-called fuel impurities, which are classified as sulphur derivatives, nitrogen derivatives, oxygen derivatives, and highly unsaturated hydrocarbons.

Engineers are of course familiar with the common characterization tests used for fuel oils, such as distillation range, gravity, cetane number, viscosity, and pour point. Mr. Pinkerton explains the interpretation of these tests and shows how refinery operations are adjusted to give the most favorable combination of fuel characteristics.

The lecture concludes with a discussion of present and future Diesel fuels from the standpoint of cost, availability, and the use of additives.

Dr. Elliott points out at the start of his well-prepared lecture on combustion of Diesel fuel oils that the physical processes involved in combustion, i.e., fuel and air handling and mixing, have been well solved by mechanical engineers. But as more stringent operating conditions have been imposed, a knowledge of the chemistry of combustion has become important. In the space available for this review it is impossible to do more than indicate the comprehensive scope of Dr. Elliott's splendid 62-page exposition by listing the headings of some of the main topics he covers. These are: mixture formation, kinetics of reaction, mechanism of auto-ignition, physical and chemical factors affecting ignition delay, fuel properties affecting ignition delay, mechanism of inflammation, factors af-

fecting rate of reaction during inflammation, reaction velocity in relation to Diesel knock, products of incomplete combustion, and combustion calculations based on chemical stoichiometry. Supporting the text is a bibliography of 61 items. Many readers will conclude, I think, that Dr. Elliott's lecture alone is well worth the price of the book.

This book is proof that lecture series of this kind are effective in promoting the objects of ASME. As a record of the first such series sponsored by the Oil and Gas Power Division of the American Society of Mechanical Engineers, it is a testimonial to the originator of the idea, Mr. W. L. H. Doyle, whose tireless efforts also brought it to fruition.

Servomechanisms

PRINCIPLES OF SERVOMECHANISMS, dynamics and synthesis of closed-loop control systems. By Gordon S. Brown and Donald P. Campbell. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1948. Cloth, $6^3/_4 \times 9^1/_4$ in., 400 pp., illus., diagrams, charts, tables, $5.

REVIEWED BY WILLIAM R. AHRENDT[2]

PROFESSORS Brown and Campbell have written a book which should be well received in both school and industry. It is a result of nine years of teaching the subject at the Massachusetts Institute of Technology, and an equal length of time spent in and directing the Servomechanisms Laboratory, a sizable group at M.I.T. serving the government and industry.

It is well-written and in an interesting fashion. By setting forth a unified treatment of servomechanisms, it can be a valuable aid to the engineering student. By presenting the manner in which mathematical methods may aid in design, it can serve a most useful purpose to many practicing engineers.

The book begins with an introductory chapter which discusses the applications of closed-loop systems and gives a concentrated sample of the entire book in a summary of methods of analysis and synthesis. Following this are chapters on the dynamics and transient analysis of servomechanisms, with introduction of the Laplace transform and the fundamentals of sinusoidal-response techniques. There follows an excellent discussion of diagrammatic representation of servos which should greatly assist the student who is confused by the seeming complexity of physical apparatus.

The next several chapters deal with appropriate amplification of the frequency method of analyzing and designing servomechanisms, using both linear and logarithmic co-ordinates. The subjects discussed include the setting of system gain to meet prescribed conditions, alteration of the response of the system by the introduction of frequency sensitive networks, and the shapes of various transfer loci and their meaning. Unfortunately, the explanation of system stability and how to determine it graphically is not altogether clear.

Next is an analytical discussion of the effect of load torque disturbances, followed by an enlightening chapter on experimental studies of a servomechanism. Here a servo is described, together with the apparatus that may be used to measure its sinusoidal response. A method of making measurements with the loop either open or closed is explained. The final chapter presents a graphical method of evaluating the direct and inverse transforms, with an illustrative numerical example worked out in commendable detail. The appendix includes an extensive Bibliography and a number of excellent classroom problems.

While the book presents much theoretical material which is also applicable to process control and other such problems arising in industry, it is almost entirely devoted to a study of positioning devices. This is certainly not a fault, although the authors' use of the term servomechanism implies other types of control as well. In discussing servos, however, it is regrettable that so little attention is devoted to nonlinearities, spurious signals, and other departures from idealizations found in physical systems. True, in a text of this sort, it is probably wise to idealize the servo components considerably, in order not to confound the student. It would also seem appropriate to state how departures arise, nevertheless, and the limitations they impose on servo design and test.

A further comment relates to the book's intent to present a method of synthesis, without mentioning the specifications of any servo to be designed, or even what information is contained in such a specification. Since servos should be designed for particular applications, performance can only be spoken of as "acceptable" or "optimum" in terms of its ability to meet the requirements set forth. "The transient response" of importance then becomes the servo's response to the disturbances it will meet in practice, rather than its response to an arbitrary forcing function.

In summary, it is felt that the book under review is a stimulating presentation, well worth the study of anyone interested in the field. Despite the broad background normally required for such a study, the authors have developed the subject well from elementary considerations, supplying appropriate material in the text whenever the book extends beyond the undergraduate level.

[2] President of Ahrendt Instrument Company, Washington, D. C. Mem. ASME.

Freedom and Security

FREEDOM AND THE ADMINISTRATIVE STATE. By Joseph Rosenfarb. Harper & Brothers, New York, N. Y., 1948. Cloth, $6 \times 9^1/_4$ in., 274 pp., $4.

REVIEWED BY J. M. JURAN[3]

CAN we achieve security for all while still retaining freedom of initiative for each? This old question has acquired new importance at a time when the very peace of the earth is delicately balanced between conflicting ideologies.

The book under review is at once an aid and a hindrance in this question. It is an aid because a well-read author has skillfully analyzed the relations between man and the State and has expressed himself with uncommon lucidity. It is a hindrance because the author has so lost himself in the details of his personal formula for solution that his consideration of basic premises is inadequate.

The author has no use for either the Nazi or Soviet forms of totalitarianism. He analyzes these well and presents his findings in superb diction.

The author has even less use for absolute capitalism. Here, however, his analysis leaves poise and judgment behind and descends to scorn and sarcasm. Emotion contaminates reason to an extent which beclouds the validity of reason.

Mr. Rosenfarb then spells out his own plan for achieving security while retaining freedom of initiative. The plan is government planning, up to the hilt. The government ascertains domestic needs, assigns production quotas, and imposes price controls. There are to be extensions of social security, health insurance, regulation of foreign commerce, public works, government-controlled research and public projects for the arts. There are to be instituted man-power and material priorities, ration-

[3] Professor of Administrative Engineering, New York University, New York, N. Y. Mem. ASME.

ing "in unusual cases", consumer "regulation or guidance", a government news service, and government supervision of public opinion polls. Strikes are to be prohibited.

To do all this there would be set up the peacetime equivalents of the Office of Price Administration, the War Labor Board and so on. In fact, part of Mr. Rosenfarb's case is that government planning in this form did exist during the war, that it worked, and that democracy was not replaced by totalitarianism. Therefore, he reasons, government planning can work in peacetime.

Why do this at all? Says the author, to avoid the next depression, to maintain full employment, to make everyone secure. Capitalism has failed to do these things, and so the body politic must.

To many, the foregoing list of government activities would of itself spell totalitarianism. Mr. Rosenfarb thinks not. His thesis is that the Nazi and Soviet dictatorships had dictatorial intent from the start. A planned economy, he thinks, can still retain democratic "orientation." This he expects to accomplish by having only the planning done by government. The operations are to be carried out by autonomous privately owned units.

Much space is devoted to details of his formula and to a plan for administering the formula. The same formula has been proposed by many others before him, and with a similar proposal for administration. Actually these details are secondary. Of primary importance are the premises behind all this. As to these premises, the author, like many before him has failed to grasp the nettle.

After rejecting absolute capitalism, government ownership, and government spending, Mr. Rosenfarb concludes that government planning is the only remaining choice. This is unrealistic. In reality there are many stages between absolute capitalism and full government planning. The author does not examine the possibility of going only part way.

Even more fundamental is the distinction between government planning and government regulation. The latter is a "thou shalt not" limitation imposed to correct abuses as they develop, and has been the practice in this country. The former is a positive "thou shalt" regulation and has appeared in any force only as a wartime measure. The possibility of solution by extending regulation has likewise not been examined by the author.

Most fundamental of all is the question of whether so sweeping a list of government planning activities will set into motion an irreversible train of events leading to dictatorship. Such was the thesis of F. A. Hayek's "The Road to Serfdom." Mr. Rosenfarb denies this but does not answer it. Is risk of depression to be minimized at the risk of dictatorship?

Finally there is the manner of administration. Mr. Rosenfarb falls into the common error of comparing the present system, at its present level of administration, with his system under a theoretically perfect level of administration. It is dangerous naivété to assume that for the new system there will be available a new race of men who are devoted to the public good rather than to their own good.

The author repeatedly points to the operation of a planned economy during the last war as proof that government planning can work and that it can leave democracy unscathed. On both counts there is futher naivété. While the historian will indeed marvel at the job of production achieved by the United States during World War II, those of us who were in the middle of that endeavor know that there were colossal wastes and blunders. The history of capitalism is also a history of tremendous achievement containing colossal wastes and blunders. It is possible, by ignoring appropriate segments of the evidence, to make out a good record of performance either for capitalism or for government planning. In like manner, it is naive to consider that the public who accepted the regulations of World War II while they were fighting for their lives would accept such measures under less exacting circumstances.

Mr. Rosenfarb and other advocates of broad government planning must nevertheless be credited with having a program for action such as is lacking among those who would stand pat somehow. Of course, the morbid fellow who decides to shoot himself also has a program for action, but he thereby sets into motion an irreversible train of events. It is clear that the advocates of the existing order had better get out a program for action before there is common cry for action such as we heard in the early thirties. Failing this, the action taken may well be precisely the thing Mr. Rosenfarb has so neatly packaged.

American Arbitration

AMERICAN ARBITRATION, ITS HISTORY, FUNCTIONS AND ACHIEVEMENTS. By Frances Kellor. Harper & Bros. New York, N. Y. 1948. Cloth $5^1/_2 \times 8^1/_4$, 262 pp., $3.

REVIEWED BY CHARLES W. LYTLE[4]

THIS book is a thorough authoritative exposition of the history, functions, and achievements of the American Arbitration Association, not of American arbitration as a whole. Because of the all-inclusive title the book is bound to be a let-down, at least to the thousands who have been familiar with arbitration as practiced outside this association. Granted that this association has achieved much in civil and commericial arbitration and that right now it has the broadest scope of any one agency engaged in arbitration, yet it is not justified under the title in ignoring all other efforts and successes in forwarding the principle of arbitration.

It is true that some of the federal and state boards have used the word conciliation or mediation rather than arbitration, but most if not all of them have practiced arbitration and have added much to the general experience. This neglect and the crusading tone of the author leaves this reader with the suspicion that the object of the book, realized or unrealized, is propaganda for the association first and for the principle second.

Part 1 gives a little ancient history, very spotty, and then gets down to the American Arbitration Association history, financing and publicizing. It ends with a chapter called, "Towards a Science of Arbitration." Part 2 starts with "General Practice of Arbitration" and because it describes *the system* is more interesting. The system here is characterized by predetermined policies, rules of procedure, permanently accessible facilities, and panels of competent arbitrators available in any locality. Anticipated arrangement for arbitration is strongly stressed because as the author says, "the casual or occasional reference to arbitration, that occurs after a dispute has arisen, is usually so difficult to arrange, and the proceeding is so haphazard, that references to arbitration possess neither the uniformity nor the frequency that is characteristic of arbitrations that arise out of clauses in contracts."

We are not impressed with the idea of frequency as an ideal but compared to frequency of litigation, strikes, and lockouts, which are implied, frequency of arbitration is indeed preferable. Nothing is said about labor-management dealing which makes both cessation of work and arbitration infrequent. Doubtless

[4] Professor of Industrial Engineering, New York University, University Heights, New York, N. Y. Mem. ASME.

that is beyond the scope but engineers, who, by training and habit put preventive solutions ahead of remedial solutions, are likely to feel that arbitration is being glorified as the one solution to disputes. For instance, lawyers are given more credit for commercial and industrial peace in this book than enlightened managers and union leaders and this at least is controversial. "The Association has, in fact, opened to lawyers a general practice that is lucrative to them and of benefit to their clients, for they are the gainers in the saving of time and in the lowering of their own overhead costs."

At the same time teachers, preachers, and ex-government officials, who serve this association as arbitrators are expected to serve gratis. "When the office is honorary the arbitrator is freed from all financial interest in the matter before him. He has none of the obligations or handicaps that attach to an advocate or employer paid by a party naming him; he is free to proceed expeditiously, for he is not interested in prolonging hearings; and he is wholly independent, being beholden to no man for an office that he did not seek."

This quotation is taken from Code of Ethics for Arbitrators. It leads to a logical but shocking conclusion: "He must have sufficient leisure and financial income from his own calling to enable him to act upon an honorary basis in the rendering of a public service; and must consider his office as one of public significance and responsibility."

We challenge both of these ideas. First, if arbitration is frequent why should any man be expected to undertake job after job without pay? Only the issues that have failed of settlement, in other words the meanest problems, are ever brought to arbitration. On one occasion when this writer served gratis under the AAA he found that the first witness was a near classmate who was being paid $85,000 a year for managing the company and the unpaid arbitrator was expected to find a solution where the witness as manager had failed!

Furthermore we deny that any man likely to be selected as arbitrator would ever want to prolong one of these hearings. The truth lies in the other direction. Either party contending may be tempted to prolong a hearing if it is cheap enough. The case cited was prolonged by the parties to twelve days! Both employers and unions are usually able and willing to pay for services of an arbitrator and if the fees are equally split the arbitrator is still "wholly independent."

We think it undemocratic and exclusive of talent to set up a system so that only wealthy men and easy marks will eventually be left as arbitrators. *What is this "towards?"*

Part 3 describes association work in international commercial arbitration, a field where the AAA has done most creditably. Perhaps all engineers should know more about this. Certainly all who are engaged in foreign trade would do well to read these six chapters.

Part 4 reverts to association history and covers it in such detail that it reads like Deuteronomy but it does show that hundreds of our leaders have subscribed to the principle of arbitration and to the AAA. The paragraphs, solid with names, make a veritable honor roll.

Books Received in Library

CONTROL OF ATOMIC ENERGY. By J. R. Newman and B. S. Miller. McGraw-Hill Book Company, Inc., Whittlesey House Division, New York, N. Y., and Toronto, Canada, 1948. Cloth, $5^1/_2 \times 8^1/_4$ in., 434 pp., diagrams, tables, $5. Presenting a detailed and comprehensive analysis of the problem, this book studies the underlying philosophy of the Atomic Energy Act and its influence on business and industry. It describes the organization and structure of the Atomic Energy Commission and indicates the general pattern of controls prescribed by Congress. The production and ownership of fissionable materials, radioactive by-products, industrial and commercial uses, patents, research, and military applications are discussed.

DESIGN OF MACHINE ELEMENTS. By M. F. Spotts. Prentice-Hall, Inc., New York, N. Y., 1948. Cloth, $6 \times 9^1/_4$ in., 402 pp., illus., diagrams, charts, tables, $6.65. This book opens with a survey of prerequisite theory and continues with consideration of individual machine elements. Methods based on rational analysis are utilized. Well-known basic theories of design are presented as well as some of the newer methods. Design data usually obtained from catalogs are omitted. The text contains many illustrative examples and solutions besides a large number of problems to be worked by the student. Each chapter is concluded with a brief bibliography.

ELEMENTARY STEAM POWER ENGINEERING. By E. MacNaughton. Third edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1948. Cloth, $6 \times 9^1/_4$ in., 640 pp., illus., diagrams, charts, tables, $6.50. This book presents in a clear and concise manner the fundamental principles underlying the construction and operation of steam power plants and equipment. New data on thermodynamic principles, turbines, and boilers have been added to this edition, while the remaining material has been thoroughly revised and brought up to date. As in previous editions, practical applications have been introduced before discussions of the theoretical aspects.

ÉQUIPEMENT THERMIQUE DES USINES GÉNÉRATRICES D'ÉNERGIE ÉLECTRIQUE. By J. Ricard, preface by E. Mercier. Second edition. Dunod, Paris, France, 1948. Paper, $6^1/_4 \times 9^1/_2$, 659 pp., illus., diagrams, charts, tables, 2900 fr. This comprehensive text on the thermal equipment of electric-generation plants covers in detailed form the following topics: steam cycles; heat transmission and heat exchangers; fuels and combustion; steam boilers and boiler furnaces; feedwater treatment; condensers and auxiliary equipment; steam turbines; plant construction, layout, and economics; selection of equipment and operative procedure; and the simultaneous production of steam and electrical energy.

FATIGUE DES MÉTAUX. By R. Cazaud, preface by A. Caquot. Third edition. Dunod 92, Paris, France, 1948. Paper, $6^1/_4 \times 9^1/_4$ in., 318 pp., illus., diagrams, charts, tables, 1650 fr. The theory and characteristics of fatigue failure of metals are discussed in the light of recent developments in the field. Methods and machines for fatigue testing are described and the influence of various factors on fatigue is considered. Separate chapters are devoted to the resistance of joints and machine assemblies to fatigue, and to the improvement in endurance of machine parts. Fatigue-limit values for a large number of metals and alloys are given together with graphs and tables of other data.

GEARS, GEAR PRODUCTION, AND MEASUREMENT. By A. C. Parkinson and W. H. Dawney. Pitman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1948. Linen, $5^1/_2 \times 8^3/_4$ in., 260 pp., illus., diagrams, charts, tables, $4.50. Based on practical experience, this book provides beginners with a foundation of leading principles upon which they can usefully base any further study for specialized individual purposes. It is intended for those in the trade who have gear problems, but who have little or no background of basic knowledge of gear forms, and of the range of manufacturing and measuring methods. Special attention is paid to inspection procedure.

Great Britain. Ministry of Supply (Air Publication 970). DESIGN REQUIREMENTS FOR AEROPLANES for the Royal Air Force and Royal Navy. His Majesty's Stationery Office, London, England, 1948. Loose-leaf, stiff cardboard cover, $7^1/_2 \times 10$ in., no pagination, diagrams, charts, tables, 15s net. Intended for use by designers of airplanes for the British Government, this book contains some of the basic requirements which insure against undue risk of loss of efficiency. Basic considerations of design, strength, and stiffness are presented as well as design requirements in connection with the installation of engines, fuel, and oil systems. Insurance of reasonable service life and minimum maintenance are also considered.

GUIDE TO TECHNICAL WRITING. By W. G. Crouch and R. L. Zetler. Ronald Press Company, New York, N. Y., 1948. Cloth, $6 \times 9^1/_2$ in., 401 pp., illus., diagrams, charts, tables, $4. This book covers both the techniques of various kinds of communications and the principles of writing. The business letter, technical article, report, abstract, and types of oral communication are considered in the first section. The chapter, "Language Essentials," reviews the fundamental principles. The "Index to English Usage" which follows has been arranged alphabetically and has been limited to essentials of English and grammar which technical men must employ. Throughout, the style has been kept informal, even conversational.

HEATING, VENTILATING, AIR CONDITIONING GUIDE 1948, 26th edition. American Society of Heating and Ventilating Engineers, New York, N. Y., 1948. Fabrikoid, 1280 pp., plus Roll of Membership, 144 pp., illus., diagrams, charts, maps, tables, $7.50. This standard manual constitutes both a textbook and handbook on the design and specification of heating, ventilating, and air conditioning systems. The

technical-data section has been substantially revised to include present knowledge and engineering practice. A new chapter on corrosion and water-formed deposits, their cause and prevention, has been added. In the catalog section 230 manufacturers are represented. A convenient cross-index provides access to the more than 900 pages of technical information.

Introduction to TOOL ENGINEERING. By H. F. Owen. Prentice-Hall, Inc., New York, N. Y., 1948. Cloth, 6 × 9¼ in., 149 pp., illus., diagrams, charts, tables, $3.60. This text presents a phase of tool engineering called "manufacturing analysis." Special emphasis has been placed on the ultimate production of manufactured foods by the most economical means and the necessary procedures by which that end is obtained. Fundamentals are stressed, including equipment and processes.

INVOLUTE GEARS. By W. Steeds. Longmans, Green and Co., London, England, New York, N. Y., and Toronto, Canada, 1948. Cloth, 5½ × 8¾ in., 193 pp., illus., diagrams, charts, tables, 18s; $4.50. Intended for students, apprentices, draftsmen, and designers engaged in mechanical engineering, this book is concerned with straight, single-helical, and double-helical involute-toothed gears. In addition to a full consideration of the principles underlying the design of involute-toothed gears, it deals also with the recognized standards relating to such gears. The principles of operation of machines and processes by means of which teeth are formed are also presented. Only elementary mathematical knowledge is required.

JOB EVALUATION, a Basis for Sound Wave Administration. By J. L. Otis and R. H. Leukart. Prentice-Hall, Inc., New York, N. Y., 1948. Linen, 6 × 9½ in., 473 pp., diagrams, charts, tables, $6.65. Of interest to the executive, union leader, and student, this book delineates the principles of sound wage and salary administration based upon job evaluation. It presents the principles together with illustrations of techiques. Several individual systems are presented so that the reader may select one and adapt it to his own particular uses. A bibliography of the articles and books written during the years 1943–1946 is included.

LOW-PRESSURE-LAMINATING OF PLASTICS. By J. S. Hicks, assisted by R. J. Francis. Reinhold Publishing Corporation, New York, N. Y., 1947. Linen, 6 × 9¼ in., 162 pp., illus., diagrams, tables, $4.50. Presents the rudimentary information required by the beginner who wishes to embark upon the field of low-pressure and contact-pressure laminating of plastics. The several steps necessary in fabrication are outlined. Sources of materials required are given, and some of the pitfalls to be avoided are enumerated.

MacRae's BLUE BOOK and Hendrick's COMMERCIAL REGISTER (Consolidated), vol. 55, 1948, Fifty-fifth annual edition. MacRae's Blue Book Company, Chicago, Ill.; 147 4th Ave., New York, N. Y., 1948. Cloth, 8 × 11¼ in., 3740 pp., illus., $15; foreign, $20. This annual reference volume lists all manufacturers in the United States under a detailed product classification. The listing under each product is alphabetical by company. A complete alphabetical listing of company names, with capital ratings and local distributors, precedes the classified section. A 340-page trade-name index is included at the back of the volume.

MANUFACTURE OF GLASS. By L. M. Angus-Butterworth. Pitman Publishing Corporation, New York, N.Y., and Chicago, Ill., 1948. Linen, 5½ × 8¾ in., 274 pp., illus., tables, $6. Following an introductory historical section, the composition and properties of glass are described. The next two sections are devoted to manufacturing processes, equipment and plant. Special products and uses are dealt with briefly, and a selected bibliography of material in English is appended.

METALLURGICAL MATERIALS AND PROCESSES. By J. Elberfeld. Prentice-Hall, Inc., New York, N. Y., 1948. Linen, 6 × 9¼ in., 188 pp., illus., diagrams, charts, tables, $5; text edition, $3.75. Intended as a text for students specializing in fields other than metallurgy, this book provides a general background in the science of metals. Emphasis is given to grain structure and constitution diagrams. Among the topics included are heat-treating furnaces and their controls, the forming of metals, welding and powder metallurgy, and laboratory procedure. Questions and summaries accompany each chapter, and an outline of the chemistry necessary for understanding the text is presented.

METALS HANDBOOK 1948 edition, prepared under direction of the Metals Handbook Committee, edited by T. Lyman. American Society for Metals, Cleveland, Ohio, 1948. Fabrikoid, 8 × 11 in., 1444 pp., illus., diagrams, charts, maps, tables, $15. This comprehensive volume provides accurate technical data, specific meanings, and significant facts concerning the full range of metallurgical subjects. Over 500 individuals contributed to the revised and enlarged edition. Articles dealing with metals, processes, or methods in general are in the first section. The second section, on ferrous metals, contains new material on alloying elements in steel, and hardenability. The nonferrous section has been expanded and almost entirely rewritten, with quick-reference semitabular arrangements of the properties of nonferrous metals and alloys. The first extensive collection of alloy phase diagrams to be published in America are in the fourth and concluding section on the constitution of alloys. A detailed 60-page index covers all four sections.

MODERN PLASTICS ENCYCLOPEDIA, 1948. Plastics Catalogue Corporation, New York, N. Y. Fabrikoid, 8¼ × 11½ in., 1673 pp., illus., diagrams, charts, tables, $8.50. In addition to the material presented in the 1947 edition, there is an up-to-date catalog of stock molded parts, cast shapes, and extrusions. A new section has been added on plastic film and sheeting, presenting recent developments and listing characteristics and production data for the various film types. Other new articles include information on hydroxyethyl cellulose, inorganic plastics, chemicals for plastics, synthetic bristles, pulp molding, and laminating and resin plant equipment. There are new charts on the properties of laminates and on plastic films. "Your Product in Plastics," the lead section of the book, describes in detail 122 successful applications in 14 major classifications.

MOLYBDENUM, Steels, Irons, Alloys. By R. S. Archer, J. Z. Briggs, and C. M. Loeb, Jr. Climax Molybdenum Company, New York, N. Y., 1948. Fabrikoid, 6 × 9¼ in., 391 pp., diagrams, charts, tables, limited free distribution. This monograph deals with the properties of molybdenum and its uses in ferrous and nonferrous alloys. The fundamental effects of heat-treatment on microstructure are considered as well as the addition of molybdenum to alloys. Each different alloy is considered individually. The appendixes contain many useful charts. Each of the ten sections is followed by an extensive bibliography.

QUALITY CONTROL. By N. L. Enrick. Industrial Press, New York, N. Y., Machinery Publishing Co., Ltd., National House, Brighton, England, 1948. Fabrikoid, 6 × 9¼ in., 122 pp., diagrams, charts, tables, $3. This book intended for the practical man explains statistical quality control in generally understandable terms. The author has confined himself to the essential methods and has purposely omitted all unnecessary refinements and formulas. The two concluding chapters show where and how statistics and probability enter into modern inspection.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

QUALITY CONTROL IN INDUSTRY, Methods and Systems. By J. G. Rutherford. Pitman Publishing Corporation, New York, N. Y., and London, England, 1948. Cloth, 6 × 9¼ in., 201 pp., diagrams, charts, tables, $3.50. Recommended as a text in industrial engineering courses, this book is also a reference manual for industrial engineers, executives, and supervisors. It covers the organization, administration, and functions of a department. Explaining and illustrating the actual methods of installation, it also gives complete data for the introduction, design and use of statistical sampling techniques. Part 1 contains generalized information outlining organizational practices and methods. Part 2 discusses statistical procedures.

RECORDS MANAGEMENT AND FILING OPERATIONS. By M. K. Odell and E. P. Strong. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1947. Cloth, 6 × 9¼ in., 342 pp., illus., diagrams, charts, tables, $4. Written as a guide to records-department operations performed in business and government organizations, this book is also a reference manual for use in offices and schools. It combines the technical aspects of records handling with the training of workers in the techniques of handling records. Many suggestions are included to aid management in establishing a records department.

Reviews of PETROLEUM TECHNOLOGY, vol. 7 (covering 1941–45). F. H. Garner and E. B. Evans, editors, and G. Sell, publications secretary. Institute of Petroleum, Manson House, London, W.1, 1947. Cloth, 6 × 9¼ in., 535 pp., tables, 21s. Normally an annual publication, the present volume covers the gap resulting from the war in anticipation of the resumption of yearly issues. Reference to nearly 3500 original articles is made in this comprehensive survey covering petroleum geology, geophysics, production and refinery engineering, the chemistry and physics of petroleum, specifications and test methods for petroleum products, and alternative and synthetic fuels. Detailed author and subject indexes are provided. The most important of the subjects which had to be omitted is gasoline and other light distillates, but these omitted topics are to be included in the next volume.

THE ENGINEERING PROFESSION

October News and Notes

As Compiled and Edited by A. F. Bochenek

Food and the Engineer

IN the face of a hungry world, the Malthusian theory of population which says that man tends to outstrip his food supply, takes on a new validity. Every country in the world is confronted with a varying degree of overpopulation. While medical science is reducing the rate of dying, the engineering arts are providing the means of destructive cultivation of the arable lands. The tragedies of wind and water erosion, the lowering of the subterranean water table originating in the abuse of the land, are reducing the sources of subsistence upon which our culture is necessarily based. Unless these facts are appreciated by Eastern and Western peoples and corrective action taken by way of contraception and a return to agriculture on a sustained-yield basis, the world can look forward to famines and a decreasing standard of living.

Biological Consequences

The dual threats of diminishing food resources and increasing populations is the subject of William Vogt's recent book *Road to Survival*[1] which should make interesting reading for engineers, especially those working in the industries whose raw materials depend on the sustained fertility of the land. When industry, and by implication the engineering profession, is held responsible for contamination of streams, lowering of water tables, and an unrealistic approach to problems of flood control, engineers individually are obliged to inform themselves on the broad biological consequences of their work.

That scientists are giving priority to the problem was evident at the centenary meeting of the American Association for the Advancement of Science where a symposium was devoted to man's survival. Fairfield Osborn, president of the New York Zoological Society, stated that ecologists have computed that $2^1/_2$ acres of land of average productivity are needed to provide an adequate diet per person. Today there are less than two such acres per person and this figure is being undermined constantly by erosion and population increases.

Engineers Aid Conservation

Although voluntary control of populations still lies beyond the purview of the engineer, the problems of erosion and flood control and conservation of water have long felt the impact of his thinking. Since 1907 the American Society of Agricultural Engineers has been providing for an interchange of ideas between the engineering and biological sciences. The ASAE Soil and Water Division has devoted its program to the conservation, utilization, and management of the nation's soil and water resources.

Recent demonstrations in conservation held on farms in Maryland, Colorado, and elsewhere for the benefit of farmers, scientists, and government officials, show how significant have been the contributions of engineers. On a farm near Denver, Colo., more than 100 earth-moving machines roared through an eight-hour day, building soil-saving terraces, irrigation ditches, and performing other land surgery which enhanced the value of the property threefold.

Engineers have anticipated the will of the farmer to conserve his land. They have advanced rural electrification and provided mobile mechanical power. They have designed special earth-moving equipment. These tools await the farmer's use.

[1] Published by William Sloane Associates, Inc., New York, N. Y., 1948, Cloth $5^1/_4 \times 8^1/_4$; 335 pp., illus., $4.

Screw Threads

CONFERENCES in Washington, D. C., and New York, N. Y., attended by engineers from Great Britain, Canada, and the United States, recently broke the log jam which was holding up unification of screw-thread standards among the English-speaking nations using the inch system of measurement, and opened the way for other decisions with important implications for national defense and world trade. Additional conferences planned for this month should put the final touches on a unification process whose history reaches back through three decades. For the story see pages 930 and 931.

Education

THE spectacle of science parting company from morality, which characterized recent history in Germany, has deepened interest in the humanistic-social stem of engineering education in America. In an article, "The Education of the Engineer," by Harry S. Rogers, president of Brooklyn Polytechnic Institute, which appears in this issue, it is pointed out that "the education of engineers for responsible citizenship is being hampered by the current absence of interest in philosophy and the concentration upon testing and behavior in psychology." Scientific thought must be correlated with moral values if engineering education is to achieve a preparation for responsible citizenship.

History

A REVIEW of technology as it has influenced human progress before and since the Industrial Revolution was the subject of the keynote address delivered at the Centenary Celebration of the Austrian Society of Engineers and Architects early this summer by Karl Holey of the Vienna Institute of Technology. So spectacular have been the achievements of modern engineering that it is easy to overlook the technology of the Romans and that of the Middle Ages. Dr. Holey's article in this issue is worth reading for its perspective of the past.

Shotpeening

A MANUAL on shotpeening and revision of standards of grit and shot are objectives of the SAE Iron and Steel Technical Committee. School and industrial laboratories are seeking answers to questions of shot effect on fatigue life, importance of uniformity, correlation of fatigue testing and production performance, and others. Look for the manual in about 18 months. The standards should be available sooner.

Air Forces Progress

A REVIEW of the work of the U. S. Air Forces, marking its first year as one of the three coequal military services, reports the introduction of 13 new models of aircraft. High lights of the review which mentions the first parasite jet fighter and several new high-speed combat aircraft are published on pages 906 and 907.

Testing Machine

A FIVE-MILLION-LB universal testing machine, large enough to test assembled components of aircraft, was demonstrated recently at the Aeronautical Structures Laboratory, Philadelphia Naval Base. For an account of the demonstration and description of the machine see pages 900 and 901.

Handbook

INFORMATION on powdered-metal friction material prepared for the forthcoming ASME Metals Engineering Handbook appears on pages 869 to 875. This is the first portion of the handbook to appear in print and should give some idea of what may be expected in the other sections of the volume. The information is oriented for convenient use of the design engineer and stresses practical rather than theoretical data.

Gas-Turbine Locomotive

WITH aviation transport expected to claim priority on petroleum products during time of national emergency, the utilization of the abundant sources of soft coal by railroads is of vital importance. During the past several years, development of a coal-burning gas-turbine for locomotive power has made

significant progress. In this issue, William B. Tucker describes the construction of the gas-turbine locomotive power plant designed and now being manufactured by his company for the Locomotive Development Committee of the Bituminous Coal Research, Inc.

30 Brazilian Engineers Entertained by EJC

A GROUP of about 30 Brazilian engineers were entertained at the Engineers' Club, New York, N. Y., on Oct. 4, 1948, by representatives of the Engineers Joint Council and officers and staff members of the national societies represented on EJC, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers.

The Brazilian group was headed by Argemiro Conte de Barros, president, the Engineers Institute of Sao Paulo and Armando Arrude Pereira, president, Manufacturers Center, Sao Paulo. Dr. L. W. Bass, past-president, AIChE, chairman EJC, welcomed the visitors.

In responding for the Brazilian engineers, Mr. Pereira spoke of the First Congress of the the Union of Pan American Engineers to be held in Rio de Janiero in July, 1949, and expressed the hope that many papers would be provided for the Congress by engineers of the United States and that a large delegation of engineers would attend the Congress.

He read a letter written by Thomas Jefferson to Louis XIV of France in 1787 in which Jefferson spoke of the need for a strong and friendly Brazil, and handed a copy of the letter to Dr. Bass.

Following the reception, the Brazilian engineers were escorted to the Engineering Societies Building for a visit to the Engineering Societies Library.

1948 Power Show Promises New Innovations

A NUMBER of innovations designed to improve the performance of power plants are promised for the 18th National Exposition of Power and Mechanical Engineering, to be held at Grand Central Palace, New York, N. Y., Nov. 29–Dec. 4, 1948.

Among the developments which members will see at the exposition is a 2000-hp fluid drive capable of pumping a million pounds of water an hour into a high-pressure boiler. Another exhibit will feature a type of steam-turbine centrifugal marine boiler feed pump that is said to have made an almost clean sweep in tankers since its introduction. An improved method of removing tramp iron from coal will be demonstrated; also a number of engineering improvements which have greatly improved the performance of a well-known spreader stoker. These include an electrohydraulic drive, alternate pusher coal feed, and an "incremental" control valve for feed regulation.

With smoke prevention coming into critical regard in many communities, there will be considerable interest in a new "Robot-Eye" combustion control that automatically regulates the fuel-air ratio for smaller and medium-sized heavy-oil-fired boilers, effecting an efficiency that is said to be comparable with larger plants, yet without the danger of forming smoke. With a thought for the exigencies of the fuel situation there will also be the exhibitor of a package-type steam generator who features provision for a quick change-over of the "automatic fuels" light and heavy oil and gas.

In the long line of new instruments already assured for the exposition are a new pyrometer; a multiple recorder which traces four lines on a chart simultaneously; and several newly developed methods of automatic pH control.

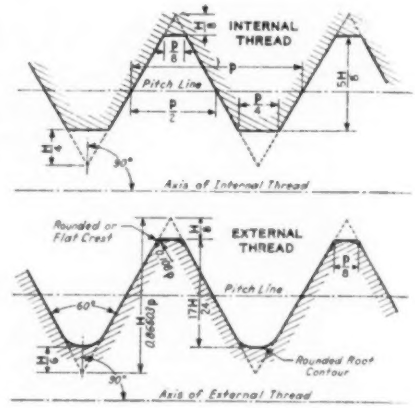


FIG. 1 AMERICAN SCREW THREAD FORMS

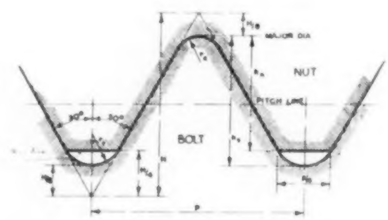


FIG. 2 BRITISH SCREW THREAD FORM

Agreement Near on Unification of Screw Threads by Great Britain, Canada, and United States

AN international standardization program of major importance to the mechanical, electrical, automobile, aircraft, and machine-tool industries, as well as numerous other industries using bolts, nuts, screws, and other threaded components in the manufacture of their products, bids fair to be completed successfully in the near future. This program is the unification of the American and British standard systems of screw threads.

The British system was originated by Whitworth in 1845 and is based on a thread angle of 55 deg and a thread form having rounded crests and roots. The American system, originally developed by Sellers in 1864, has a thread angle of 60 deg and a thread form with flat crests and roots. The pitches for a given diameter are generally the same in both systems, so that American and British bolts and nuts of the same nominal size usually can be assembled without difficulty. A troublesome exception is the half-inch coarse thread for which the Americans have adopted a pitch of 13 threads per in., against 12 threads per in. in the British system. Furthermore, it obviously is impossible to establish accurate fits between components having threads with different angles.

Unification an Old Problem

As early as the first World War, it was found that unification of the two systems would be desirable. A major difficulty was that both systems had become adopted widely in the respective countries. Canada, with its close tie to the United Kingdom, but a close neighbor to the United States, has the difficulty of dealing with both systems, even in peacetime.

The first effort toward unification was made in 1919, when an American delegation of experts went to London. These discussions produced no result. A second effort made in 1926 by a British delegation visiting this country was also unsuccessful. During the second World War, the screw thread problem came up again in very acute form. American industry was supplying the British with a large volume of war equipment, built to British specifications, and hence requiring the use of British Standard Whitworth threads.

Truncated Whitworth Form

This situation led to the adoption in the United States, as a temporary emergency measure, of the American War Standard for Screw Threads of Truncated Whitworth Form (American Truncated Whitworth Threads). These threads have a 55-deg angle and are interchangeable with British Standard Whitworth threads. However, they can be produced by means of threading tools having flat crests and roots when new, that is, tools of the type used for producing American Standard threads. This war emergency measure, although helpful to American industry, still left the two major inch-thread systems in existence side by side, and focused the attention again on the need for their unification. This problem was taken under consideration again in 1943, when British and Canadian delegations met in New York with American experts. This conference was followed by discussions in London, 1944, when an American-Canadian mission went overseas. Again in 1945, American and British experts went to Ottawa for a third conference, where basic agreement on a unification plan was reached. The British consented to change from the 55 to the 60-deg thread angle, and a basic profile, thereafter sometimes designated as the "ABC form" of thread (meaning American-British-

Canadian) was adopted to serve as the starting point for unified standards to be developed in the three countries concerned. Accordingly, the Americans agreed to adopt a rounded root for the external thread (bolt). They also agreed to consider the adoption of the $^1/_2$-in. coarse thread with 12 threads per in. The agreement was such that the Americans could continue to use the same truncated profile they had adopted in American Standard B1.1-1935, while the British could adhere to the rounded crest and root characteristic of the Whitworth profile.

Since the Ottawa conference, the technical committees in the United States and the United Kingdom in charge of screw thread standardization, have developed proposals for the revision of the existing national standards, along the lines agreed to at the Ottawa conference. The Canadians, interested mostly in having to deal with only one system instead of two, have signified that they would be willing to adopt any solution on which the United States and Great Britain could agree. The American, British, and Canadian committees have kept in continuous touch by correspondence, and through occasional delegations of experts. Also, the committees of the ASA and the BSI have kept in close touch with the military services in their countries. Thus in the United States, ASA Sectional Committee B1 on Standardization and Unification of Screw Threads has been co-operating with the Interdepartmental Screw Thread Committee representing the government services.

Standard Now in Semifinal Draft

Following a series of meetings between a British delegation and American experts held in New York and Washington last July, the negotiations have now proceeded to the point where a semifinal draft of a Proposed American Standard for Unified Screw Threads (For Screws, Bolts, Nuts, and Other Threaded Parts), as well as a draft of a Provisional British Standard for Unified Screw Threads are ready for consideration by the industries and government services in the respective countries, and subsequent approval by the national standards bodies.

How unification of practice and hence interchangeability of American and British screw threads has been achieved, will be clear from Figs. 1 and 2 representing the thread forms as illustrated in the American and British drafts, respectively.

The American draft has been worked out by the Sectional Committee on Standardization and Unification of Screw Threads, B1, organized in 1921 under ASA procedure and sponsored jointly by The American Society of Mechanical Engineers and the Society of Automotive Engineers. Chairman of the sectional committee is Elmer J. Bryant (Greenfield Tap and Die Corp.) and vice-chairman Frank P. Tisch (Pheoll Manufacturing Company). Secretary and assistant secretary are W. R. Penman and R. L. Riley (both of Bethlehem Steel Company). Chairman of Subcommittee No. 1 on Revision of the American Standard is Paul J. DesJardins (Pratt & Whitney Company), with W. H. Gourlie (Sheffield Corporation) as secretary.

The third effort toward American-British-Canadian unification was started in 1943 under the auspices of the Combined Production and Resources Board, which made the arrangements for the conferences in New York (1943), London (1944), and Ottawa (1945). After the abolition of the Board, a sponsors council composed of the representatives of The American Society of Mechanical Engineers, Society of Automotive Engineers, and the American Standards Association was created under chairmanship of William L. Batt, past-president and honorary member ASME, to lend support to the work carried on through the facilities of the national standards bodies in the three countries: the American Standards Association, the British Standards Institution, and the Canadian Standards Association.

Great credit should be given to the sponsors, officers, and members of the American committees and to their counterparts in the United Kingdom for the encouraging progress which has been made to date.

It is hoped that final agreement among the technical committees in the three countries may be reached at a conference to be held in this country during the month of November.

This agreement will be a matter of major importance to the industrial groups in the three countries having an interest in screw-thread standardization, as well as to the military services, with a view to the manufacture and servicing of numerous kinds of war equipment.

Conference on Research Administration a Success

THE second annual Conference on the Administration of Research, sponsored by the school of engineering of The Pennsylvania State College, was held at State College, Pa., on Sept. 13–15, 1948, attracting over 130 research executives from government, industry, and the universities.

The conference provided the opportunity for an interchange of information on tested practices in research administration. The program of seven papers was directed at three main themes: (1) Research management and policy; (2) personnel in research; and (3) small research laboratories. The first two subjects were approached from the angle of government, industry, and the university. Speaking on research management and policy were Col. O. C. Maier, chief of plans, engineering division, Air Materiel Command; C. G. Suits, vice-president and director of research, General Electric Company; and A. E. White, director, Engineering Research Institute, University of Michigan.

Ernst Weber, Polytechnic Institute of Brooklyn; R. D. Bennett, technical director, Naval Ordnance Laboratory, and H. B. Richmond, chairman of the board, General Radio Corporation, spoke on personnel in research. G. A. Rosselot, director, The State Engineering Experiment Station of the Georgia Institute of Technology, spoke on small research laboratories.

Dean H. J. Masson of New York University was chairman of the round-table conferences at which were discussed many topics such as management, design and location of laboratories, and finances.

Maj. Gen. F. O. Carroll, director, research and development, Air Materiel Command, was the speaker at the dinner which was held on Sept. 13.

The two annual conferences have been well received. Discussion of papers has been spirited and pertinent. Because this movement fills an important function in the field of research administration, a third conference has been scheduled for Sept. 12–14, 1949, to be held at The Pennsylvania State College, State College, Pa.

Scientific and Synthetic Analysis Committee Formed

ROBERT L. Stearns, president of the University of Colorado, was recently named chairman of a newly formed Scientific and Synthetic Analysis Committee by Vannevar Bush, until recently chairman of the Research and Development Board, National Military Establishment.

The new committee was established by the Secretary of Defense as a unit of the Research and Developnent Board to examine all aspects of military activity, such as supply, transportation, stock piling, troop movements, and combat operations, to ascertain where scientific methods, particularly those making use of high-speed computers, can be utilized to improve existing procedures.

Also named to serve on the committee are Luis de Florez, Mem. ASME, president of the de Florez Engineering Company, Inc., Hartford, Conn., and L. K. Marshall, president and board chairman of the Raytheon Mfg. Company, Waltham, Mass. Representatives of the Army, Navy, and Air Force will be appointed to the committee by the secretaries of their departments.

AIEE to Sponsor Electric Welding Conference

ARC and resistance welding technical sessions will be featured at a Conference on Electric Welding to be held in Detroit, Mich., on Dec. 6, 7, and 8, 1948. The Conference is sponsored by the American Institute of Electrical Engineers in co-operation with the Detroit section of the American Welding Society, and the Industrial Electrical Engineers' Society of Detroit.

Program high lights include an inspection trip through an automobile assembly plant and high-speed movies of the welding arc, as well as a session on inert arc welding and radio interference. Round-table discussion of three-phase and single-phase resistance welding will consider weldability and effect of wave shapes on results obtained.

Maintenance and maintenance training will be subjects for an evening session open to the public. Completing the program will be sessions devoted to plant-distribution systems and utility problems in supplying power for welding loads.

Illinois Tech Offers Free Monthly Lectures

A Mechanics Colloquium to be sponsored by the Illinois Institute of Technology, Chicago, Ill., during the 1948–1949 academic year was announced recently. Open to the public without charge, the Colloquium consists of eight lectures, the third of which will be given Dec. 1, 1948. Dr. J. J. Stoker of New York University, New York, N. Y., will speak on "An Applied Mathematician's Views of the Problem of Elastic Stability."

The lectures begin at 8:00 p.m. and are preceded by a dinner. Members who want regular announcements of the lectures 10 days in advance should notify R. L. Janes, Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

Other lectures will cover such subjects as brittle coatings as a tool for experimental stress analysis, some phenomena of nonsteady flow, bridges and aerodynamics, and others.

Meetings of Other Societies

November 4–5
Society of Automotive Engineers, Inc., national fuels and lubricants meeting, The Mayo Hotel, Tulsa, Okla.

November 7–10
American Institute of Chemical Engineers, New York meeting, Hotel Pennsylvania, New York, N. Y.

November 8–11
American Petroleum Institute, 28th annual meeting, Stevens Hotel, Chicago, Ill.

November 10–13
The Society of Naval Architects and Marine Engineers, annual meeting, Hotel Waldorf-Astoria, New York, N. Y.

December 5–9
The American Society of Refrigerating Engineers, 44th annual meeting, Statler Hotel, Washington, D. C.

December 13–15
American Society of Agricultural Engineers, winter meeting, The Stevens Hotel, Chicago, Ill.

January 10–14
Society of Automotive Engineers, Inc., annual meeting and engineering display, Hotel Book-Cadillac, Detroit, Mich.

January 19–22
American Society of Civil Engineers, annual meeting, Hotel Commodore, New York, N. Y.

January 20–21
American Management Association, finance conference, Hotel Pennsylvania, New York, N. Y.

Armed Forces Seek File of Research and Development Engineers

A NEW volume, "Who's Who in Engineering Research" was projected at a conference of representatives of government agencies, Armed Forces, and engineering societies held in the Office of Naval Research, Washington, D. C., Oct. 11, 1948.

The conference was called to discuss means of providing the National Military Establishment with a source file of approximately 25,000 engineers qualified in the field of engineering research and development.

Preliminary plans call for the list to be composed of names contributed by engineering societies with the Engineers Joint Council serving as the contact or liaison organization. The task of preparing the summarized biographies and publishing the list as a "Who's Who in Engineering Research would be undertaken by a private publishing contractor."

Financial support would come in part from the Office of Naval Research and some other public research foundation.

As projected the list would include less than 50 policy consultants, 1000 top engineering consultants, and 25000 key engineers qualified in engineering research and development.

After the list has been developed it is to be maintained by the National Military Establishment. The responsibility of the engineering societies would be to provide the names, maintain contact with individual members, and keep membership-address lists up to date. Another task for each society would be to define engineering research and development as these terms apply to its members.

The Engineers Joint Council was represented at the conference by Crosby Field, Fellow ASME. R. L. Goetzenberger, Mem. ASME, represented The American Society Mechanical Engineers and Engineers' Council for Professional Development. Representatives of six other engineering organizations were present.

Wood Research at VPI

A GRANT of $2000 was recently given to the Virginia Polytechnic Institute by The Research Corporation, New York, N. Y., for a study of wood box columns.

Wood box columns have been in satisfactory use, although test and design data have not been available. The investigation was set up in order to determine formulas for their design. With the availability of the test data, it will be possible to use wood box columns much more satisfactorily, especially in engineering design with wood. More than 100 tests on full-size wood box columns of various cross sections, of various plank thicknesses and plank arrangements, are being planned, with the planks nailed, or nailed and glued. The investigation will be conducted under the supervision of E. George Stern, Mem. ASME, director of the VPI Wood Research Laboratory.

G. R. Henninger, New Editor of IES Journal

APPOINTMENT of G. Ross Henninger, formerly of the headquarters staff of the American Institute of Electrical Engineers and editor of *Electrical Engineering*, as director of publications of the Illuminating Engineering Society was recently announced. Mr. Henninger assumed his new duties Oct. 1, 1948.

The appointment was part of a program to facilitate expansion of IES activities. With the January, 1949, issue the *IES Journal of Electrical Engineering* will be enlarged from the 6 × 9 to a 9 × 12 in. size and the advertising policy will be altered to welcome advertising pertinent to all phases of the lighting industry.

Mr. Henninger will correlate all IES publications and will serve as editor of *Illuminating Engineering*.

C. S. Rich New AIEE Editor

Charles S. Rich, formerly secretary of the AIEE technical program committee, was named to succeed Mr. Henninger as editor of *Electrical Engineering* and the AIEE Transactions. He joined the AIEE staff in 1930 and has been responsible for administrative details involved in handling hundreds of technical papers annually.

A. B. Parsons Resigns as AIME Secretary

AFTER eighteen years in the position, A. B. Parsons has resigned as secretary of the American Institute of Mining and Metallurgical Engineers. The resignation becomes effective in February, 1949; but, in the meantime, Dr. Parsons will be on leave of absence. E. H. Robie, who has been Dr. Parsons' principal assistant during nearly all of his tenure of office, will be acting secretary during the remainder of the year.

During Dr. Parsons' administration the number of professional divisions of the Institute has been increased from 4 to 7, the number of local sections from 26 to 44, and the membership, including students, from 7800 at the end of 1933 to 18,750. The annual budget of the Institute has increased from $120,000 in 1933 to $378,000 in 1947.

Midwest Power Conference Has New Director

STANTON E. WINSTON, Mem. ASME, dean of the evening division and professor of mechanical engineering at Illinois Institute of Technology, Chicago, Ill., resigned recently as director of the annual Midwest Power Conference.

Roland A. Budenholzer, Mem. ASME, professor of mechanical engineering at Illinois Tech., was named to replace Dean Winston, who has served as conference director since 1940.

The conference is held annually in Chicago

as a project of the Illinois Institute of Technology. Midwestern colleges and local sections of engineering societies co-operate in presenting papers on power production, transmission, and utilization. The next conference will be held April 18–20, 1949.

C. M. Allen to Receive John Fritz Medal

CHARLES METCALF ALLEN, honorary member, ASME, professor of hydraulic engineering at Worcester Polytechnic Institute and director of the Alden Hydraulic Laboratory, Worcester, Mass., has been selected to receive the 1949 John Fritz Medal, it was announced by the Board of Award.

Professor Allen was cited "for exceptional achievement in hydraulic Engineering," and as "the founder of a notable hydraulic laboratory; prominent teacher, consultant, inventor and author."

Honorary membership in The American Society of Mechanical Engineers was conferred on Professor Allen in 1944. He served as manager of the Society from 1928–1931 and vice-president from 1931–1933. In 1936 he received the ASME Worcester Reed Warner Medal.

The John Fritz Medal was established in 1902 as memorial to the engineer and industrialist whose name it bears. It is awarded annually, if suitable candidates are presented, "for scientific or industrial achievement."

The John Fritz Medal Board of Award is composed of four representatives from each of the four national engineering founder societies, The American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers.

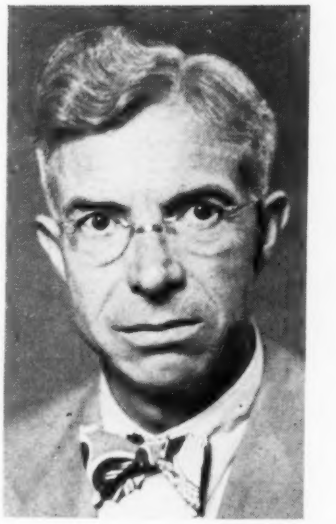
Professor Allen was given the status of professor emeritus at Worcester Polytechnic Institute in 1945, after a teaching career of 50 years which began upon his graduation from the same school in 1894. He received the master-of-science degree in 1899 and in 1929 his alma mater conferred on him the honorary degree of doctor of engineering.

Professor Allen is a member also of the American Society of Civil Engineers, the Society for the Promotion of Engineering Education and the American Association for the Advancement of Science. He is a past-president of the Boston Society of Civil Engineers.

E. H. Colpitts Receives 1948 Cresson Medal

EDWIN H. COLPITTS, director of The Engineering Foundation, New York, received the 1948 Cresson Medal of The Franklin Institute, Philadelphia. It was presented to him by Richard T. Nalle, president of the Institute, at the traditional Medal Day ceremonies in Philadelphia, Pa., Oct. 20, 1948.

Founded in 1948, the Cresson Medal is one of the highest honors of the Institute and is given "for discovery or original research, adding to the sum of human knowledge, irrespective of commercial value." It is awarded to Dr. Colpitts for his pioneering achievements leading to the development of practical systems of long-distance communication, both by wire and radio.



H. S. BEAN, MEM. ASME, WHO HEADS NEW NBS CAPACITY, DENSITY, AND FLUID METER SECTION

H. S. Bean Heads New NBS Section

HOWARD S. BEAN, Mem. ASME, widely known for his extensive work in the field of fluid measurements and on the application of rate-of-flow meters to the fuel-gas industry, has been given added responsibilities as chief of the newly formed Capacity, Density, and Fluid Meter Section of the National Bureau of Standards.

The new section was formed by consolidation of the Gas Measuring Instrument Section, of which Mr. Bean has been chief, and the Capacity and Density Section. Mr. Bean has been active on ASME research committee work serving on the Fluid Meters and Power Test Code Committee since 1937. He is also active in the ASME Washington, D. C., Section.

F. C. Frary Awarded ASM 1948 Gold Medal

THE 1948 Gold Medal of the American Society for Metals was presented to Francis Cowles Frary, director of research, Aluminum Company of America, during the National Metal Congress and Exposition held in Philadelphia, Pa., Oct. 25–29, 1948.

The award was created in 1943 and is given annually. Dr. Frary has contributed knowledge in all phases of research on aluminum, from the processing of bauxite and the production of the metal to its final application. He was the first to produce aluminum of 99.99 per cent purity.

Dr. Frary received his master's degree from the University of Minnesota where he later taught for four years.

New Literature

ASRE

Eight-page pamphlet, AD 12, on air purification by use of activated carbon. Contains information on control of odors in air conditioning, selection of purifiers, installation, economy in air recovery, and computations for ventilation or air recovery. Price 45 cents.

Ten-page pamphlet, AD 18-R, on refrigeration of lemons and grapefruit. Covers handling methods, color processing, storage methods, and air conditioning equipment. Price 50 cents.

Order from American Society of Refrigeration Engineers, 40 West 40th St., New York 18, N. Y.

AWS

Five-page booklet on "Welding Piping in Marine Construction." Revision of 1938 edition. Suggests rules to effect uniformity in classification and basic welding requirements for piping of governing agencies in shipbuilding industry. Price 25 cents.

Committee report on "Survey of Automatic Arc and Gas Welding Processes as Used in the Automotive Industry, D7.2-48-T." Contains brief general discussion of the seven principal automatic arc and gas welding processes. Price 30 cents.

Order from American Welding Society, 33 West 39th St., New York 18, N. Y.

WSE

The Western Society of Engineers has combined the WSE Journal and Bulletin into a new $8^1/_4 \times 11$ in. monthly magazine called *Midwest Engineer*. Will not be published during June, July, and August.

ASME

"Letter Symbols for Mechanics of Solid Bodies ASA Z10.3–1948." Revision of 1932 issue. Six pages. Price 30 cents.

"Cast-Iron Flanges and Flanged Fittings for Refrigerant Piping, Class 300, ASA B16.16." Covers sizes, markings, materials, wall thickness, tests, facing, and bolting for such fittings. Eleven pages. Price 45 cents.

Proceedings of the 1947 National Conference on Petroleum Mechanical Engineering held at Houston, Texas, Oct. 5–8, 1947. 8×11 in., 152 pages. Contains 20 papers on materials, equipment, production, refining, transportation pertaining to petroleum industry. Price $4.50.

1948 Addenda to ASME Boiler Construction Code, pertaining to Power Boiler Code, Miniature Boiler Code, Locomotive Boiler Code, Low-Pressure Heating Boiler Code, Unfired Pressure Vessel Code, Welding Qualifications Code, and Materials Specifications Section. Price for set $1.50; for constituent codes, 25 cents each.

ASME NEWS

Excellent Technical Program Planned for ASME 1948 Annual Meeting, Nov. 28–Dec. 3

Headquarters: Hotel Pennsylvania

THE CONCENTRATION of mechanical engineers in New York, N. Y., during the first week of December, 1948, will probably be attributed by the men who watch the charts of professional migrations to the coincidence of the 1948 Annual Meeting of The American Society of Mechanical Engineers to be held at the Hotel Pennsylvania, Nov. 28–Dec. 3, and the 1948 Power Show which is to hold open house a stone's throw away at the Grand Central Palace.

An ASME Annual Meeting is not a rare phenomenon nor can the coincidence with the Power Show be called uncommon, but a program so rich and varied, shedding so much light on so many of the frontiers of mechanical engineering as does the 1948 technical program, is not a routine achievement of a routine organization. This year's program veritably stirs with the restlessness which now characterizes the engineering profession.

What about creative engineering? What are France, Denmark, and Norway doing in time and motion studies: How does nylon rate as a bearing material? What are the courts doing to the American patent system? Do engineers have any business prying into the forces active in the human mechanism? Just what is a press fit? Can an extrusion process be applied to ice making?

These are but a few of the questions which having excited the curiosity of engineers, have been subjected to engineering analysis, and are now to be reported to engineering audiences in open sessions. Engineers whose job it is to apply knowledge are perhaps more conscious of lack of knowledge than other groups in the social structure. Each year the technical sessions of the ASME throw more light on the inner periphery of the gulf of darkness. Each year engineers become more aware of the boundlessness of the outer reaches.

The 1948 Annual Meeting program does just that. It reflects the postwar mechanical engineer not only preoccupied with the machine, production methods, basic science, but also with human relations and engineering aspects of the human body, and curious about matters not only in a field peculiarly his own, but also in others in which he is no longer a stranger.

1948 Annual Meeting Theme

Training the engineering graduate by industry for industrial management is the theme about which the 1948 program was planned. This subject will be discussed at the keynote luncheon on Monday, Nov. 28, at which L. A. Appley, president, American Management Association, will define a philosophy for the young graduate engineer and the industry which employs him.

Fifteen other luncheons and dinners, including the annual banquet, have been planned to make available time and opportunity for relaxation and fellowship in a crowded five-day program of technical sessions at which more than 200 papers will be presented.

Pres. E. G. Bailey will further develop the Annual Meeting theme when he addresses the banquet on "Engineering Opportunities in Industry."

Plant Trips

The Metropolitan Section is working on a program of plant-inspection trips to laboratories and industries in the New York area. The program is so tentative at time of going to press that no information can be given. Details of the plants to be inspected will be given in the final program which will be available at the registration desk.

Reunions

With so many engineers expected in New York for the Annual Meeting, many alumni associations are taking the opportunity to hold reunions. Such meetings have already been planned by Cornell, Harvard, New York University, Worcester Polytechnic Institute, and Rensselaer Polytechnic Institute groups. What facts are available are listed in the tentative program for Thursday evening, Dec. 2. Other information will be available in the final program and at the registration desk.

Annual Meeting Preprints

At time of going to press 93 of the Annual Meeting papers were in preprint form or in the process of being preprinted. These papers are identified in the tentative program which follows by a code number. A preprint order

ASME Annual Meeting Session to Be Televised and Broadcast on America's Town Meeting of the Air, WJZ–TV, Channel 7

IF YOU want more proof of the wealth and variety of the ASME 1948 Annual Meeting Technical Program, consider this: On Tuesday, Nov. 30, from 8:30 to 9:30 p.m., e.s.t., the ASME Engineers Civic Responsibility Committee session will be nationally broadcast and widely televised on America's Town Meeting of the Air program, originating from radio Station WJZ and television Station WJZ-TV, Channel 7.

Eminent engineers will tell the nation of the engineer's ability and eagerness to contribute to the solution of national problems.

More than 250 radio stations will carry the broadcast to every ASME Section. The televised program is expected to be picked up by television stations in Philadelphia, Washington, and Boston, and should be seen within a 50 mile radius of these cities.

For the first time, every member of the Society will be able to participate in an ASME Annual Meeting. Sections are urged to hold special radio and television meetings on Tuesday, Nov. 30, to tune in on the program and following the broadcast to carry on the discussion with reference to their own civic problems.

SKY LINE OF UPTOWN MANHATTAN ISLAND AS SEEN FROM ACROSS THE EAST RIVER. THE CENTER FOREGROUND SHOWS THE SITE WHERE THE BUILDINGS OF THE UNITED NATIONS ARE TO BE ERECTED

form appears on page 58 of the advertising section for convenience of members who wish available preprints in advance of the Meeting.

The Tentative Program

Members are cautioned not to regard the program which follows as the final one. It is a tentative one and is accurate only as of October 1. While this issue is on the press, changes will be coming in. Members who plan to come long distances for attendance at one or two sessions are advised to confirm dates and times by wire with Headquarters before setting out.

MONDAY, NOVEMBER 29

Applied Mechanics (I)

9:30 a.m.

Bending of Rectangular Plates Subjected to a Uniformly Distributed Lateral Load and to Tensile or Compressive Forces in the Plane of the Plate, by H. D. Conway, professor of mechanics, Cornell University, Ithaca, N. Y. (48—A-12)

On the Design of Large Elevator Platforms, by F. Hymans, consulting engineer, Larchmont, N. Y. (48—A-10)

A Strain-Energy Expression for Thin Elastic Shells, by H. Langhaar, associate professor of mechanics, University of Illinois, Urbana, Ill. (48—A-9)

Stresses and Displacements in a Semi-Infinite Elastic Body With Parabolic Cross Section Acted on by Its Own Weight Only, by R. J. Hank, materials and test engineer, and F. H. Scrivner, senior research engineer, Texas Highway Department, Austin, Texas (48—A-27)

On the Stability of Plates Reinforced by Ribs, by J. M. Klitchieff, Belgrade University, Yugoslavia. (48—A-8) (By title)

Note on the Bending of Circular Plates of Variable Thickness, by H. D. Conway, professor of mechanics, Cornell University, Ithaca, N. Y. (48—A-6) (By title)

Heat Transfer (I)

Mechanical Cleaning of Fouled Heat Exchanger Tubes, by Alexander John, Jr., assistant general manager, Thos. C. Wilson, Inc., Long Island City, N. Y.

Chemical Cleaning of Heat Exchange Equipment, by C. M. Loucks district chemist, Dowell, Inc., Cleveland, Ohio, and C. H. Groom, development engineer, Dowell, Inc., Tulsa, Okla.

Scale Formation and Control in Compression Distillation of Sea Water, by J. J. Campobasso, E. D. Badgers & Sons, Boston, Mass., and A. Latham, Jr., Arthur D. Little, Incorporated, Cambridge, Mass.

Inhibited Acid Cleaning of Nonferrous Condenser Tubes, by F. J. Allen, York Corporation, York, Pa.

Production Engineering (I)—Management (I)

Statistical Inspection Pictures Cut Material Procurement Costs, by Dorian Shainin, chief inspector, Hamilton Standard Propellers Division, United Aircraft Corporation, East Hartford, Conn. (48—A-88)

Can Management Afford Not to Be Quality-Conscious? by William MacCrehan, Jr., director of gage laboratory, New York University, New York, N. Y.

Hydraulic (I)

Symposium on Heat Balance

12:15 p.m.

Keynote Luncheon

Speaker: L. A. Appley, president, American Management Association, New York, N. Y.

Subject: Opportunity for and Responsibility to the Young Graduate Engineer in Industry.

Education (I)—Management (II) Keynote Session

2:30 p.m.

Expanding Opportunities for Engineers in Industry—Whither Engineering Employment? by A. A. Potter, dean of engineering, Purdue University, West Lafayette, Ind.

The Government and the Future Employment of Engineers, by M. W. Trytten, National Research Council, Washington, D. C.

The Small Manufacturing Company as an Opportunity for Engineering Graduates, by Crosby Field, president, Flakice Corporation, Brooklyn, N. Y.

Hydraulic (II)

Elements of Graphical Solution of Water Hammer Problems in Centrifugal Pump Systems, by A. J. Stepanoff, development engineer, Ingersoll Rand Company, Phillipsburg, N. J. (48—A-89)

Pipe Factors for Quantity Rate-Flow Measurements With Pitot Tubes, by R. G. Folsom, professor of mechanical engineering, and H. W. Iverson, assistant professor of mechanical engineering, University of California, Berkeley, Calif. (48—A-35)

The Measurement of Turbulent Components in a Liquid in Pipe Flow by the Method of Electromagnetic Induction, by L. M. Grossman, lecturer on mechanical engineering, University of California, Berkeley, Calif.

Production Engineering (II)—Materials Handling (I)

Automation, by N. L. Bean, director, production engineering, Ford Motor Company, Detroit, Mich.

Manufacture of the Triclad Motors, by P. Lebeubaum, motor engineering division, General Electric Company, Lynn, Mass.

Heat Transfer (II)

Cleaning Tubular Heat Exchangers, by P. F.

Official Notice

ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 29, 1948, at 5:00 p.m. in the Pennsylvania Hotel, New York, N. Y., as a part of the Annual Meeting of the Society.

Dougherty and C. H. Brooks, process engineers, Sun Oil Company, Philadelphia, Pa.
Fouling Rates and Cleaning Methods in Refinery Heat-Exchangers, by R. C. Butler and W. N. McCurdy, Jr., process engineers, Standard Oil Development Company, Elizabeth, N. J.
The Rate of Fouling and Cleaning of Unfired Heat-Exchanger Equipment, by J. H. Weiland, Jr., R. C. McCay, and J. E. Barnen, The Texas Company, Port Arthur, Texas
Current Practices in the Cleaning of Marine Type Heat Exchangers, by H. E. Bethon, Bureau of Ships, Navy Department, Washington, D. C.

Gas Turbine Power (I)—Machine Design (I)

Introductory Remarks, by L. N. Rowley, managing editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y.
Mechanical Investigations of Gas-Turbine Components, by Carl Schabtach, staff assistant to manager of engineering, apparatus department, General Electric Company, Schenectady, N. Y. (48—A-47)
Current Design Practices for Gas-Turbine Power Elements, by H. D. Emmert, Jr., engineer in charge, turbopower development department, research section, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. (48—A-69).
Heat Engines Based on Wave Processes, by Arthur Kantrowitz, associate professor, graduate school of aeronautical engineering, Cornell University, Ithaca, N. Y.

6:00 p.m.

Applied Mechanics Dinner

Speaker: Harold Vagtborg, president, Southwest Research Institute, San Antonio, Texas

Applied Mechanics (II)

The Dynamic Response of a Simple Elastic System to Antisymmetric Forcing Functions Characteristic of Airplanes in Unsymmetric Landing Impact, by Joseph B. Woodson, mechanical engineer, National Bureau of Standards, Washington, D. C. (48—A-16)
Thermal Stresses in a Rectangular Plate Clamped Along an Edge, by B. J. Aleck, materials engineer, M. W. Kellogg Company, Jersey City, N. J. (48—A-28)
Stress Concentration Around a Triaxial Ellipsoidal Cavity, by E. Sternberg, associate professor of mechanics, and M. A. Sadowsky, associate professor of mathematics, Illinois Institute of Technology, Chicago, Ill. (48—A-29)
The Shape of a Piston Ring in Its Unrestrained State, by C. T. Chang, research engineer, Wilkening Manufacturing Company, Philadelphia, Pa. (48—A-21)
Slow Motion Pictures of Impact Tests by Means of Photoelasticity, by L. Föppl, professor of applied mechanics, Institute of Technology, Munich, Germany (48—A-24) (By title)
Dynamic Capacity of Rolling Bearings, by Gustaf Lundberg, professor of elasticity, Chalmers University of Technology, Gothenburg, Sweden, and Arvid Palmgren, in charge engineering and mechanical research, SKF Industries, Inc., Philadelphia, Pa. (48—A-19) (By title)

Note to Junior Members

JUNIOR members attending the 1948 ASME Annual Meeting are urged to participate in an informal meeting of the ASME Junior Committee on Thursday, Dec. 2, 2:30 p.m., at the Pennsylvania Hotel.

D. E. Jahncke, chairman, Junior Committee, will discuss the work of the Committee and its plans for the future. B. H. Edelstein will tell about the job of editing the Junior Forum.

Your ideas and opinions should help to clarify the relationship of the junior member to the Society.

8:15 p.m.

Management (III)

American Management's Contribution to World Recovery in the Field of Human Relations, by Lemuel R. Boulware, vice-president, General Electric Company, New York, N. Y. Mr. Boulware and five of his associates will be available for questions on the floor after the initial 90-minute presentation.

Production Engineering (III)—Machine Design (II)

The Commercial Weldery—A New Service and Tool for Industry, by K. F. Ode, works manager, Trackson Company, Milwaukee, Wis. (48—A-92)
Thermit Welding Procedure and Application, by J. H. Deppeler, consulting engineer, Metal and Thermit Corporation, New York, N. Y.

Heat Transfer (III)

Panel Discussion

Nature of Deposits, by L. F. Collins, The Detroit Edison Company, Detroit, Mich.
Problems in Steam Power Plants, by W. L. Webb, mechanical-engineering division, American Gas & Electric Service Corporation, New York, N. Y.
Problems in Marine Power Plants, by D. F. Kinert, commander, U.S.N., Bureau of Ships, Navy Department, Washington, D. C.
Fouling and Cleaning Problems Pertaining to Process Industries, by R. L. Clapper, head of service department, Griscom-Russell Company, New York, N. Y.
Influence of Fouling on Design of Heat Exchangers, by R. M. Armstrong, manager of heat-transfer division, Downingtown Iron Works, Downingtown, Pa.

Lubrication—Petroleum (I)

Film Pressure Distribution in Grease-Lubricated Journal Bearings, by Gunther Cohn, research engineer, Franklin Institute Laboratories for Research and Development, Philadelphia, Pa., and Jess W. Oren, research engineer, Armstrong Cork Company, Lancaster, Pa. (48—A-31)
The Load-Carrying Capacity of Hydrodynamic Oil Films, by Arvid E. Roach, Research Laboratories Division, General Motors Corporation, Detroit, Mich. (48—A-74)
Viscosity-Temperature Properties of Liquids at High Temperatures, by W. A. Zisman, head, lubrication sections, chemistry division, Naval Research Laboratory, Washington, D. C.

Gas Turbine Power (II)—Fuels (I)—Power (I)

Gas-Turbine Locomotive Units—Combustion-Chamber Development for Burning Heavy Oil, by B. O. Buckland and D. C. Berkey, General Electric Company, Schenectady, N. Y.
Effects of Fuel Properties on the Performance of the Turbine-Engine Combustor, by L. C. Gibbons, National Advisory Committee for Aeronautics, Washington, D. C.
NACA Research on Cooling of Gas-Turbine Blades, by O. W. Schey, chief of the compressor and turbine research division, National Advisory Committee for Aeronautics, Washington, D. C.

TUESDAY, NOVEMBER 30

9:30 a.m.

Hydraulic (III)

Repairs to Hydro Adjustable Blade Turbines by Welding, by Joel B. Justin, consulting engineer, Justin & Courtney, Philadelphia, Pa., and E. T. Davis, mechanical engineer, Indiana Michigan Electric Company, Mishawaka, Ind.
Cavitation, by R. T. Knapp, professor of hydraulic engineering, California Institute of Technology, Pasadena, Calif.
Flow and Rotating Machinery and Other Hydrodynamic Problems, by R. T. Knapp, H. A. Hollander, A. J. Acosta, and W. C. Osborne all of California Institute of Technology, Pasadena, Calif.

Management (IV)

Current Time and Methods Study and Wage-Incentive Practices in France, by Lucien Lauru, consulting engineer, Paris, France
Current Time and Methods Study and Wage-Incentive Practices in Denmark, by Hans Torbol, manager, The Northern Cable & Wire Works, La Coursvej, Copenhagen, Denmark
Current Time and Methods Study and Wage-Incentive Practices in Norway, by Bernhard Hellern, general manager, A/S E. Sunde & Company, Ltd., Torvgaten, Oslo, Norway

Discussion

Don Copell, chief engineer, Wagner Baking Corporation, Brooklyn, N. Y.
Phil Carroll, Jr., registered professional engineer, Maplewood, N. J.
Harold Engstrom, chief industrial engineer, American Home Products Company, New York, N. Y.

Rubber and Plastics (I)

Soft Rubber Bearings—Design Features and Methods of Application Under Conditions of Water Lubrication, by A. Bednar, vice-president, Lucian Q. Moffitt, Inc., Akron, Ohio
Report on Friction Test on Flow Control of Continuous Film Rubber Bearing, by J. W.

Stanley, production manager, The E. J. Willis Company, New York, N. Y.

Nylon as a Bearing Material, by D. B. Hanson, E. I. du Pont de Nemours and Company, Arlington, N. J.

Gas Turbine Power (III)—Railroad (I)—Fuels (II)—Power (II)

A 5000-Kw Gas Turbine for Power Generation, by Alan Howard and C. J. Walker, General Electric Company, Schenectady, N. Y. (48—A-83)

Test of a 4800-Hp Gas-Turbine Power Plant, by Alan Howard and B. O. Buckland, General Electric Company, Schenectady, N. Y.

Heat Transfer (IV)

A Study of Three Tube Arrangements in Unbaffled Tubular Heat Exchangers, by O. P. Bergelin, associate professor of chemical engineering, E. S. Davis and H. L. Hull, research fellow, University of Delaware, Newark, Del. (48—A-34)

Cooling-Tower Analysis, by Joseph Lichenstein, consulting engineer, Foster-Wheeler Corporation, New York, N. Y. (48—A-32)

Errors in High-Temperature Probes for Gases, by E. M. Moffatt, chief engineer, The Airflo Instrument Company, Glastonbury, Conn. (48—A-52)

Education (II)

What Is Being Done in Recognizing or Finding the Qualities Essential to Creative Engineering?, by Kenneth W. Vaughn, Pinecrest Farm, Hyde Park-on-Hudson, N. Y.

What Is Being Done in Industry to Utilize and Further Develop These Qualities? (to be announced)

Applied Mechanics (III)

An Energy Method for Determining the Dynamic Characteristics of Mechanisms, by Bayard E. Quinn, associate professor, mechanical engineering, Purdue University, West Lafayette, Ind. (48—A-18)

Vibration of Slender Bars With Discontinuities in Stiffness, by William T. Thomson, associate professor of mechanics, University of Wisconsin, Madison, Wis. (48—A-17)

The Use of the Centrifugal Pendulum Absorber for the Reduction of Linear Vibration, by F. Everett Reed, assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (48—A-25)

Stability of Linear Oscillating Systems With Constant Time Lag, by H. I. Ansoff, research assistant applied mechanics, Brown University, Providence, R. I. (48—A-22) (Presented by G. F. Carrier, professor, Brown University, Providence, R. I.)

Theory of the Damped Dynamic Vibration Absorber for Inertial Disturbances, by John E. Brock, assistant professor of mechanics, Washington University, St. Louis, Mo. (48—A-4) (By title)

12:15 p.m.

Power Luncheon

Presiding: J. I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md.

Speaker: Joseph Pope, vice-president, Stone & Webster Engineering Corporation, New York, N. Y.

Subject: Utility and Industrial Co-Operation in Generation and Use of Steam and Electricity

Heat Transfer Luncheon

Presiding: A. P. Colburn, assistant to president, University of Delaware, Newark, Del.

Speaker: D. M. Patterson, Wright-Patterson Air Force Base, Dayton, Ohio

Subject: Cabin Conditioning Problems at Supersonic Velocities

Machine Design Luncheon

Toastmaster: George F. Nordenholt, editor, *Product Engineering*, McGraw-Hill Publishing Company, Inc., New York, N. Y.

Speaker: H. A. Toulmin, Jr., firm of Toulmin and Toulmin, Dayton, Ohio

Subject: Patents and the Courts—Reform or Revolution

2:30 p.m.

Hydraulic (IV)

The Parallel Development of Heavy Self-Contained Hydraulic Presses in the United States and Great Britain, by F. H. Towler, director Towler Bros. Ltd., Rodley, Leeds, England (48—A-33)

Speed-Regulation Computations for Hydraulic Turbines, by Robert Lowy, consulting engineer Upper Darby, Pa. (48—A-37)

Metals Engineering (I)—Pressure Vessel Research Committee (I)

Pressure Vessel Design Theory on Measured Versus Computed Stresses in Head-to-Shell Juncture, by R. G. Sturm, supervisor, project engineer, H. G. Larew, H. L. O'Brien, project engineer, E. Wetterstrom, H. W. Marsh, and J. Evans, research staff, Purdue University, West Lafayette, Ind.

The Effect of Fabrication Processes on Steels Used in Pressure Vessels—Progress Report No. III—Effect of Plastic Strain and Heat-Treatment on Tensile and Notch Properties of a Rimmed and a Killed Steel, by C. J. Osborn, A. F. Scotchbrook, R. D. Stout, and B. G. Johnston, research staff of Fritz Laboratory, Lehigh University, Bethlehem, Pa.

Management (V)—Production Engineering (IV)
Quality Control

Contributions of Statistics to the Science of Management, by W. A. Shewhart, Bell Laboratories, Murray Hill, N. J.

Selling Statistical Methods to Industry, by J. M. Juran, chairman and head, department of administrative engineering, New York University, New York, N. Y.

Rubber and Plastics (II)

Frictional Characteristics of O-Rings With a Typical Hydraulic Fluid, by L. E. Cheyney, W. J. Mueller, and R. E. Duval, Battelle Memorial Institute, Columbus, Ohio (48—A-64)

Laboratory Testing of Rubber Bearings, by J. R. Beatty, compounding research and D. H. Cornell, Manager, Engineering Services, B. F. Goodrich Research Center, Brecksville, Ohio

Advances in Rubber During 1948, by Lois W. Brock, librarian, Gilbert H. Swart, director of research, and E. V. Osberg, sales executive, General Tire and Rubber Company, Akron, Ohio

Advances in Plastics During 1948, by E. L. Kropscott, assistant manager, Dow Chemical Company, Midland, Mich.

Industrial Instruments and Regulators (I)

A Classification of Linear Transfer Members, by H. L. Mason, research professor, mechanical engineering, Iowa State College, Ames, Iowa (48—A-84)

Extended Criteria for Control, by Abraham Soble, engineer, General Electric Company, Schenectady, N. Y. (48—A-85)

Heat Transfer (V)

Supersonic Convective-Heat-Transfer Correlation From Skin-Temperature Measurements on a V-2 Rocket in Flight, by R. H. Norris, section engineer, and W. W. Fischer, development engineer, General Electric Company, Schenectady, N. Y. (48—A-54)

Aerodynamic Heating and Convective-Heat-Transfer Summary of a Literature Survey, by H. A. Johnson, associate professor of mechanical engineering, University of California, Berkeley, Calif., and M. W. Rubesin, aeronautical research scientist, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffett Field, Calif. (48—A-39)

An Analytical Investigation of Convective Heat Transfer From a Flat Plate Having a Stepwise Discontinuous Surface Tempera-

Graphic Arts Exhibit Planned for Annual Meeting

THE Photographic Group of the Metropolitan Section of The AMERICAN SOCIETY OF MECHANICAL ENGINEERS is sponsoring a graphic arts exhibit at the 1948 Annual Meeting.

All members and nonmembers are cordially invited to submit exhibits.

All photographic prints must be mounted on 16 × 20 in. cardboard mounts. There is no time limit in which the pictures should be taken. There will be five subdivisions consisting of portraits, landscapes and seascapes, pictorial or still-life, genre, and mechanical or industrial pictures. A total of ten prints, but not more than five from one group may be submitted.

Other exhibits of graphic arts will be accepted but not more than five examples from any one group will be accepted.

Pictures and exhibits should be mailed to Edward S. Rowell, ASME Headquarters, 29 West 39th St., New York 18, N. Y. Entries will be accepted until November 20.

ture, by M. W. Rubesin, aeronautical research scientist, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffett Field, Calif. (48—A-43)

An Analysis of the Heat Transfer to Turbulent Boundary Layers in High-Velocity Flow, by R. A. Seban, lecturer in mechanical engineering, University of California, Berkeley, Calif. (48—A-44)

Machine Design (III)

Roller-Chain Designs and Their Engineering Applications, by Joseph Joy, sales engineer, Diamond Chain and Manufacturing Company, Indianapolis, Ind. (48—A-66)

Tests on V-Belt Drives and Flat-Belt Crowning, by C. A. Norman, professor, The Ohio State University, Columbus, Ohio

A Simplified Fine-Pitch Worm-Gearing Standard, by Louis D. Martin, gear engineeer, Eastman Kodak Company, Rochester, N. Y. (48—A-82)

ASME Calendar

of Coming Events

Nov. 3–4, 1948
ASME Fuels Division—AIME Coal Division Conference, Greenbrier Hotel, White Sulphur Springs, W. Va.

Nov. 28–Dec. 3, 1948
ASME Annual Meeting, Hotel Pennsylvania, New York, N. Y.

Jan. 10–14, 1949
ASME Materials Handling Division and Management Division Conference, Convention Hall, Philadelphia, Pa.

Apr. 25–29, 1949
ASME Oil and Gas Power Division Conference, Hotel Sherman, Chicago, Ill.
(Final date for submitting papers—Dec. 1, 1948)

May 2–4, 1949
ASME Spring Meeting, New London, Conn.
(Final date for submitting papers—Jan. 1, 1949)

June 27–30, 1949
ASME Semi-Annual Meeting, San Francisco, Calif.
(Final date for submitting papers—Feb. 1, 1949)

Sept. 28–30, 1949
ASME Fall Meeting, Erie, Pa.
(Final date for submitting papers—May 1, 1949)

Nov. 27–Dec. 2, 1949
ASME Annual Meeting, New York, N. Y.
(Final date for submitting papers—Aug. 1, 1949)

(For Meetings of other Societies see page 932)

3:00 p.m.

Power (III)—Applied Mechanics (IV)—Gas Turbine Power (IV)

Reaction Tests of Turbine Nozzles for Supersonic Velocities, by J. H. Keenan, professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Reaction Tests of Turbine Nozzles for Subsonic Velocity, by Hans Kraft, aerodynamicist, General Electric Company, Schenectady, N. Y.

Power-Plant Cycle Evaluation, by J. K. Salisbury, division engineer, thermal-power-systems division, General Engineering and Consulting Laboratory, General Electric Company, Schenectady, N. Y. (48—A-57)

6:00 p.m.

Gas Turbine Power Dinner

Presiding: J. T. Rettaliata, dean of engineering, Illinois Institute of Technology, Chicago, Ill.

Toastmaster: T. E. Purcell, general superintendent, power stations, Duquesne Light Company, Pittsburgh, Pa.

Presentation: Gas Turbine Power Division Award: To Charles G. Curtis, New York, N. Y., "For pioneering work in the field of gas turbines."

Speaker: Walker Cisler, executive vice-president, The Detroit Edison Company, Detroit, Mich.

Subject: The Gas Turbine's Place in the World Power Field.

Hydraulic Oldtimers' Dinner

Presiding: D. J. McCormick, sales manager S. Morgan Smith and Company, York, Pa.

8:15 p.m.

Industrial Instruments and Regulators (II)—Power (IV)

Presiding: M. D. Engle, mechanical engineer, Pennsylvania Power and Light Company, Allentown, Pa.

Panel Discussion: Progress in Automatic Control of Steam Plants. A panel composed of representatives from utility plants, industrial plants, consulting engineers, and automatic control manufacturers will lead the discussion.

Petroleum (II)—Machine Design (IV)

Plain Bearings—Today and Tomorrow, by E. Crankshaw, assistant chief engineer, Cleveland Graphite Bronze Company, Cleveland, Ohio (48—A-63)

Babbitting Methods for Bearings (To be announced)

Applied Mechanics (V)—Aviation (I)—Management (VI)

Symposium on Biomechanics and Prosthesis

Introductory Remarks: Artificial-Limb Making in Transition From Craft to Technology, by E. F. Murphy, assistant research director, Prosthetic and Sensory Aids Service, Veterans Administration, New York, N. Y.

Mechanics of the Artificial Arm, by G. M. Motis, engineering supervisor, prosthesis development division, Northrop Aircraft, Inc., Hawthorne, Calif.

The Application of Fundamental Data in the Design of Lower Extremity Prosthesis, by John G. Catranis, president, Catranis, Inc., Syracuse, N. Y.

The Forces and Moments in the Leg During Level Walking, by B. Bresler, research engineer and assistant professor of civil engineering, University of California, Berkeley, Calif., and J. P. Frankel, research engineer and instructor in engineering, University of California, Los Angeles, Calif. (48—A-62)

Fundamental Studies on Upper Extremities, by Craig Taylor, associate professor of engineering, University of Calif., Los Angeles, Calif.

Engineers Civic Responsibility Committee

Town Hall Broadcast

Hydraulics (V)—Applied Mechanics (VI)

(Papers to be announced)

WEDNESDAY, DECEMBER 1

9:30 a.m.

Railroad (II)—Industrial Instruments & Regulators (III)

Progress in Railway Mechanical Engineering—Report of Committee RR-6 Survey, by T. F. Perkinson, assistant manager, transportation, engineering division, General Electric Company, Erie, Pa.

Locomotive Proportions and Transmission Systems, by Rupen Eksergian, chief consulting engineer, The Budd Company, Philadelphia, Pa.

Symposium: Nondestructive Testing of Parts and Assemblies From Motive Power and Rolling Stock

Magnetic Particle Testing, by L. B. Jones, consulting engineer, Paoli, Pa. (48—A-79)

Fluorescent-Liquid Inspection, by Ray McBrian, engineer of standards and research, Denver and Rio Grande Railway Company, Denver, Colo. (48—A-80)

The Theory of Ultrasonic Materials Testing, by E. VanValkenburg, development engineer, General Electric Co., Schenectady, N. Y.

Ultrasonic Instruments for Nondestructive Testing, by Daniel Farmer, electrical engineering supervisor, Sperry Products, Incorporated, Danbury, Conn.

Practice, by Earl Hall, engineer of tests, Erie Railroad, Meadville, Pa.

Management (VII)

A Critical Comparison of Management Tools at Home and Abroad—Organization and Administrative Practices.

Industrial Organization in the U. S. and Abroad, by Harry Arthur Hopf, president, Hopf Institute of Management, Inc., Ossining, N. Y.

Fuels (III)

The Application of Combustion Research to the Development of Smokeless Stoves for Bituminous Coal, by Bertrand A. Landry, and Ralph A. Sherman, Battelle Memorial Institute, Columbus, Ohio

Catalytic Cracking Plants for Relieving Gas Utility Peak Loads, by C. G. Milbourne, head, gas-production division, Surface Combustion Corporation, Toledo, Ohio

Oil and Gas Power (I)

The Construction of a Temperature-Entropy Chart for Air and Its Application to Explosive Combustion Studies, by Harold A. Everett, professor emeritus of mechanical engineering, The Pennsylvania State College, State College, Pa.

A Theoretical Investigation of Detonation in Internal-Combustion Engines, by Major F. A. Bates, special WPNS project, Albuquerque, N. M., and Captain J. L. Quinnelly, Ft. Knox, Ky.

Heat Transfer (VI)—Applied Mechanics (VIa)

Heat Transfer to Liquid Metals Flowing in Asymmetrically Heated Channels, by W. B. Harrison, Oak Ridge National Laboratory, Oak Ridge, Tenn., and J. R. Menke, president, Nuclear Development Associates, Inc., New York, N. Y. (48—A-51)

Heat Transfer to Water at High Flux Densities With and Without Surface Boiling, by Frank Kreith, senior research engineer, and Martin Summerfield, chief, rockets and materials division, jet-propulsion laboratory, California Institute of Technology, Pasadena, Calif.

Flow of Heated Gases, by Stanley Thompson, research engineer, North American Aviation, Inc., Municipal Airport, Los Angeles, Calif.

A Ventilated Thermal Insulation Structure for High-Temperature Marine Power Plants, by A. L. London, professor of mechanical engineering, and C. R. Garbett, instructor, mechanical engineering, Stanford University, Stanford University, Calif. (48—A-46)

Power (V)

Operating Experiences in Connection With Regenerative Reheat Turbine Installations, by C. A. Robertson, engineer, steam-turbine department, Allis-Chalmers Manufacturing Company, West Allis, Wis. (48—A-91)

Developments in Resuperheating in Steam-Power Plants, by E. E. Harris, assistant division engineer, and A. O. White, section engineer, turbine engineering division, General Electric Company, Schenectady, N. Y.

Steam Turbines for Reheat Cycle, by E. E. Parker, division engineer, steam turbine and generator engineering division, General Electric Company, Schenectady, N. Y. (48—A-58)

Reheating in Steam Turbines, by R. L. Reynolds, manager, central station turbine section, Westinghouse Electric Corporation, Lester, Pa.

Machine Design (V)

Styling and the Mechanical Designer, by Earl D. Hay, professor of design, department of mechanical engineering, Iowa State College, Ames, Iowa (48—A-48)

What Can the Machine-Design Field Expect From the Recent College Graduate?, by C. Higbie Young, professor in charge, department of machine design, The Cooper Union, New York, N. Y. (48—A-72)

12:15 p.m.

Management Luncheon

Presiding: W. R. Mullee, professor, department of administrative engineering, New York University, New York, N. Y., and J. Keith Louden, assistant to the president, York Corporation, York, Pa.

Speaker: H. B. Maynard, ASME Towne lecturer, president, Methods Engineering Council, Pittsburgh, Pa.

Subject: The Role of Scientific Management in World Recovery.

IIRD Luncheon

Fuels Luncheon

Presiding: T. C. Cheasley, assistant to president, Sinclair Coal Company, Kansas City, Mo.

Speaker: W. C. Schroeder, chief, synthetic-fuels branch, U. S. Bureau of Mines, Washington, D. C.

Subject: Synthetic-Liquid-Fuel Research.

1:30 p.m.

Railroad (III)—Industrial Instruments and Regulators (IVa)

Symposium: What Is a Press Fit?

Theory and Laboratory Investigation, by H. J. Schrader, professor, department of theoretical and applied mechanics, University of Illinois, Urbana, Ill.

Practical Consideration in Railroad Work, by E. H. Weston, mechanical engineer, Chicago and Northwestern Railway System, Chicago, Ill. (48—A-77)

Problems of a Locomotive Builder, by J. K. Erzer, section engineer, locomotive engineering division, General Electric Company, Erie, Pa.

2:30 p.m.

Machine Design (VI)

Engineering Problems in the Design of Heavy Mining and Process Machinery, by F. R. Gruner, research and development engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. (48—A-71)

The Mechanical Seal—Its Construction, Application and Utility, by Carl E. Schmitz, vice-president, director of engineering, Crane Packing Company, Chicago, Ill. (48—A-70)

Involute-Gear Geometry, by C. E. Grosser, professor, mechanical engineering, Syracuse University, Syracuse, N. Y. (48—A-73)

Power (VI)

Steam-Generating Equipment for Resuperheating Cycles, by Martin Frisch, vice-president in charge of engineering, Foster Wheeler Corporation, New York, N. Y.

High-Pressure Boilers With Reheaters, by W. H. Rowand, chief engineer, The Babcock & Wilcox Company, New York, N. Y. (48—A-60)

Modern Reheat Boilers, by W. S. Patterson, executive assistant, engineering department, Combustion Engineering Company, Incorporated, New York, N. Y.

Management (VIII)—Education (III)

Opportunities for the American Engineer Abroad, Introductory Remarks by E. G. Bailey, president, ASME, New York, N. Y.

Opportunities and Requirements for U. S. Engineers Abroad, by Lloyd J. Hughlett, managing editor, McGraw-Hill International Corporation, New York, N. Y., and James A. Thompson, vice-chairman of the board, McGraw-Hill Publishing Company, Incorporated, New York, N. Y.

Some Implications of Foreign Service in the Engineering Field, by Lawrence Duggan, president, The Institute of International Education, New York, N. Y.

Fuels (IV)

Combustion Ash Collection for the Small Power Plant, by Phillip F. Best, chief mechanical engineer, Thermix Corporation, Greenwich, Conn. (48—A-55)

How to Cut Small Boiler-Plant Costs by Mechanical Coal and Ash Handling, by C. E. Miller, technical adviser, H. M. Carlson, research engineer, and R. B. Engdahl, supervisor, Battelle Memorial Institute, Columbus, Ohio

Studies on Fly-Ash Erosion, by M. A. Fisher, and E. F. Davis, Institute of Gas Technology, Armour Research Foundation, Chicago, Ill. (48—A-53)

Oil and Gas Power (II)

Energy in the Engine Exhaust, by T. C. Tsu, research associate, and P. H. Schweitzer, professor of engineering research, consulting engineer, The Pennsylvania State College, State College, Pa. (48—A-56)

Torsional Viscous-Friction Dampers, by J. C. Georgian, torsional analyst, Nordberg Manufacturing Company, Milwaukee, Wis. (48—A-67)

Applied Mechanics (VII)

On the Impact Behavior of a Material With a Yield Point, by Merit P. White, professor of civil engineering, University of Massachusetts, Amhert, Mass. (48—A-3)

Fatigue Under Combined Pulsating Stresses, by Harry Majors, Jr., assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., B. D. Mills, Jr., professor of mechanical engineering, University of Washington, Seattle, Wash.; and C. W. MacGregor, professor of applied mechanics, Massachusetts Institute of Technology, Cambridge, Mass. (48—A-7)

Fracture of Gray Cast Iron Tubes Under Biaxial Stresses, by R. C. Grassi and I. Cornet, assistant professors, University of California, Berkeley, Calif. (48—A-15)

Numerical Solution of the Elasto-Plastic Torsion of a Shaft of Rotational Symmetry, by R. P. Eddy, mathematician, mechanics division, Naval Ordnance Laboratory, Washington, D. C., and F. S. Shaw, deputy chief, structures section, division of aeronautics Council for Scientific and Industrial Research, Melbourne, Australia. (48—A-20)

General Features of Plastic-Elastic Problems as Exemplified by Some Particular Solutions, by Rodney Hill, Cavendish Laboratory, Cambridge, England (48—A-13) (By title)

6:30 p.m.

Annual Dinner

Speaker: E. G. Bailey, president, ASME, New York, N. Y.
Subject: Engineering Opportunities in Industry

THURSDAY, DECEMBER 2

9:30 a.m.

Railroad (IV)

High-Speed Freight Trains and Equipment

Traffic Considerations Leading to the Establishment of High-Speed Freight Service and Related Operating Problems, by F. N. Nye, assistant to general freight traffic manager, New York Central System, New York, N. Y. (48—A-78)

Protection of Lading and Equipment, by Paul W. Kiefer, chief engineer motive power and rolling stock, A. M. Miers, assistant engineer, rolling-stock department, and L. D. Hays, air-brake engineer, New York Central System, New York, N. Y. (48—A-76)

Process Industries (I)

Ice Making by the Extrusion Process, by John R. Watt, assistant professor of mechanical engineering, University of Texas, Austin, Texas (48—A-36)

Sink-Float Processes, by John T. Sherman, mining engineer, American Cyanamid Company, New York, N. Y. (48—A-40)

Metal-Cutting Data

Influence of Steel Hardness in Face Milling, by J. B. Armitage, vice-president, and A. O. Schmidt, research engineer, Kearney and Trecker Corporation, Milwaukee, Wis. (48—A-30)

Mechanics of Formation of the Discontinuous Chip in Metal Cutting, by Michael Field, applied research director, Metcut Research Associates, and M. E. Merchant, senior research physicist, The Cincinnati Milling Machine Company, Cincinnati, Ohio

A Constant-Pressure Lathe Test for Measuring Machinability of Free-Cutting Steels, by F. W. Boulger, supervising metallurgist, H. L. Shaw, and Hugo E. Johnson, research engineers, Battelle Memorial Institute, Columbus, Ohio (48—A-86)

Vessels Under External Pressure—Pressure Vessel Research Committee (II)

Allowable Working Pressures for Long Tubes Subject to External Pressure, by M. B. Higgins, supervisory engineer, The Texas Company, New York, N. Y.

Out-of-Roundness Tolerances for Vessels Subject to External Pressure, by H. L. O'Brien, project engineer, and R. G. Sturm, supervisor, project engineer, Purdue University, West Lafayette, Ind.

Aluminum-Alloy Vessels, by E. G. Kort, engineer, Alcoa Process Development Laboratories, Aluminum Company of America, New Kensington, Pa.

American Rocket Society (I)

A Study of the Parameters Affecting Over-All Rocket Performance, by Charles H. Harry, pilotless-aircraft section, Glenn L. Martin Company, Baltimore, Md.

A Survey of Injector Designs for Use in Liquid-Propellant Rocket Motors, by B. N. Abramson, Bell Aircraft Corporation, Buffalo, N. Y.

Materials Handling (II)

Applied Mechanics (VIII)—Aviation (II)—Heat Transfer (VII)

A Study of the Supersonic Axial-Flow Compressor, by William A. Loeb, engineer, gas turbine department, De Laval Steam Turbine Company, Trenton, N. J. (48—A-5)

Investigation of the Variation of Point Unit Heat-Transfer Coefficients for Laminar Flow Over an Inclined Flat Plate, by Robert M. Drake, Jr., instructor, mechanical engineering, University of California, Berkeley, Calif. (48—A-2) (To be presented by Dr. Ernest Eckert)

Flow Through a Pipe With a Porous Wall, by F. C. W. Olson, research associate, Ohio State University, Put in Bay, Ohio (48—A-1)

Supersonic Diffusers for Wind Tunnels, by E. P. Neumann, assistant professor of mechanical engineering, and F. Lustwerk, research associate, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (48—A-14)

Supersonic Flow Past Airfoil Tips, by Leon Beskin, research design division, Bureau of Aeronautics, Navy Department, Washington, D. C. (48—A-23) (By title)

12:15 p.m.

Members and Students Luncheon

Speakers: Pres. E. G. Bailey and Pres-Elect J. M. Todd

American Rocket Society Luncheon

Presiding: Charles A. Villiers, president, The American Rocket Society, New York, N. Y.
Subject: The Muroc Facility
Speaker: K. F. Mundt, chief engineer, Aerojet Engineering Corporation, Azusa, Calif.

2:00 p.m.

Railroad (V)

Braking Problems, by C. F. Hammer, engineering manager, Westinghouse Air Brake Company, Wilmerding, Pa.

Journal Bearings for High-Speed Freight Service

Roller Bearings, by W. C. Sanders, general manager, railway division, Timken Roller Bearing Company, Canton, Ohio

Solid Bearings, by E. S. Pearce, president, Railway Service and Supply Company, Indianapolis, Ind.; R. J. Shoemaker, chief engineer, Magnus Metal Division, National Lead Company, Chicago, Ill.; and I. E. Cox, vice-president in charge of engineering, American Brake Shoe Company, National Bearing Division, St. Louis, Mo.

Boiler Feedwater Studies—Power (VII)

Corrosion of Boiler Generating Tubes at Battersea and Deptford West Generating Stations, by R. L. Rees and E. A. Howes, British Electricity Authority, London Division, London, Eng.

Hydrogen Embrittlement of Heat-Transfer Surfaces in Power Boilers, by E. P. Partridge, director of research, Hall Laboratories, Inc., Pittsburgh, Pa.

Corrosion-Erosion of Boiler Feed Pumps and Regulating Valves at Marysville, Second Test Program, by H. A. Wagner, chief mechanical engineer, engineering division; J. M. Decker, research engineer; and J. C. Marsh, technical engineer, The Detroit Edison Company, Detroit, Mich.

2:30 p.m.

Process Industries (II)—Fuels (V)

Effect of the Introduction of Natural Gas on a Highly Industrialized Territory Previously Supplied by Manufactured Gas, by Paul R. Taylor, vice-president, Stone and Webster Service Corporation, New York N. Y. (48—A-41)

Considerations Affecting Sound Utilization of Gas, by Carl Wierum, industrial sales manager, Brooklyn Union Gas Company, Brooklyn, N. Y. (48—A-42)

Meeting the Peak Loads of Manufactured Gas, by E. S. Pettyjohn, director, Institute of Gas Technology, Chicago, Ill.

Aviation (III)—Gas Turbine Power (V)

Flight Testing of Jet-Propelled Aircraft as Conducted by the Air Materiel Command, by N. R. Rosengarten, chief, flight research section, flight test division, U.S.A.F. Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio (48—A-90)

A Research and Development Laboratory for Aircraft Gas Turbines, by M. C. Hemsworth, section engineer, aircraft gas turbine divisions, General Electric Company, West Lynn, Mass.

Materials Handling (III)

(Papers to be announced)

American Rocket Society (II)

Creation of High-Pressure Gas Source for Rocket Motor Propellant Supply Systems, by C. J. Turansky and R. D. Rinehart, rocket group engineers, Bell Aircraft Corporation, Buffalo, N. Y.

Metal Parts for Solid-Propellant Rockets, by L. G. Bonner, technical director, Allegheny Ballistics Laboratory, Cumberland, Md.

Metals Engineering (II)—Applied Mechanics (IX)

Strength and Failure Characteristics of Metal Membranes in Circular Bulging, by W. F. Brown, Jr., research metallurgist, flight propulsion research laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio, and F. C. Thompson, metallurgical engineer, Allegheny Ludlum Steel Corporation, Dunkirk, N. Y. (48—A-11)

A Reconsideration of Deformation Theories of Plasticity, by D. C. Drucker, associate professor of engineering, Brown University, Providence, R. I. (48—A-81)

6:00 p.m.

Aviation—American Rocket Society Dinner

Toastmaster: G. E. Pendray, president, Pendray and Liebert, New York, N. Y.

Speaker: Hugh L. Dryden, director of aeronautical research, National Advisory Committee for Aeronautics, Washington, D. C.
Awards: Three by American Rocket Society
Subject: Rockets as Research Tools in Aeronautics

8:15 p.m.

Power (VIII)

Marine Night

Marine Propulsion Gear Testing at the Naval Boiler and Turbine Laboratory, by Ivan Monk, commander, Philadelphia Naval Shipyard, Naval Base Station, Philadelphia, Pa. (48—A-50)

Machinery Installation in New Coast Guard Ice Breakers, by E. H. Thiels, captain, United States Coast Guard Headquarters, Washington, D. C.

Safety Committee—Boiler Code Committee

Cause Analysis of Boiler and Machinery Accidents, by H. W. Heinrich, assistant superintendent, engineering and inspection division, Travelers Insurance Company, Hartford, Conn.

College Reunions

Cornell University: 8:00 p.m. Cornell Club, 107 East 48th St. Speaker: T. P. Wright, vice-president, Cornell University. Subject: The Role of the University in Research. Reunion arranged by Robert B. Lea, Sperry Gyroscope Company, Great Neck, N. Y.

New York University: 5:30 to 7:30 p.m. New York University Club, 22 Washington Square North. Dinner at Faculty Club. For details phone Prof. A. H. Church, Ludlow 4-0700

Harvard University: Harvard Engineering Club. Details in final program.

Worcester Polytechnic Institute: Speaker: Admiral Watt T. Cluverius, president, W.P.I. Details in final program

Rensselaer Polytechnic Institute: 12:30 p.m. Pennsylvania Hotel Luncheon Meeting. For details inquire at registration desk

University of Michigan: 12:15p .m. Luncheon, Engineers Club, 32 West 40th Street, New York, N. Y. Arranged by F. L. Schwartz, associate professor of mechanical engineering, University of Michigan, Ann Arbor, Mich.

Metals Engineering (III)—Applied Mechanics (X)

Flow and Fracture of Metals Under Combined Stress, by John H. Holloman, research laboratory, General Electric Company, Schenectady, N. Y.

Plastic Flow of a Compressed Ring, by L. J. Klinger, Jr., research associate, Case Institute of Technology, Cleveland, Ohio, E. L. Aul, metallurgist, Clark Bros., Inc., Olean, N. Y., and George Sachs, director of national metallurgical laboratory, Jamshedpur, India. (Presented by title)

Bending of an Ideal Plastic Metal, by L. J. Klingler, Jr., research associate, Case Institute of Technology, Cleveland, Ohio, E. L. Aul, metallurgist, Clark Bros., Inc., Olean, N. Y., and George Sachs, national metallurgical laboratory, Jamshedpur, India

FRIDAY, DECEMBER 3

9:30 a.m.

Properties of Gases—Applied Mechanics (XI)—Heat Transfer (VIII)

Thermodynamic Properties of O_2, N_2, and Air at Low Temperatures, by L. C. Claitor, Elliott Company, Jeannette, Pa., and D. B. Crawford, formerly with Elliott Company, Southwest Research Institute, San Antonio, Texas (48—A-75)

Zero-Pressure Thermodynamic Properties of Carbon Dioxide, by Serge Gratch, associate, department of mechanical engineering, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa.

Report of the Working Subcommittee of the International Joint Committee on Psychrometric Data, by J. A. Goff, dean, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa.

Transport Properties of Gases and Gas Mixtures, by J. O. Hirschfelder, professor, department of chemistry, R. Byron Bird, and Ellen L. Spotz, graduate students, University of Wisconsin, Madison, Wis.

Experimental Determination of Heat Conductivity for Gases, by F. G. Keyes, professor, department of chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

The Physical Properties of Air With Reference to Meteorological Practice and the Air Conditioning Engineer, by P. A. Sheppard, professor, reader in meteorology, Imperial College of Science and Technology, University of London, London, England

Furnace Performance Factors—Power (IX)—Fuels (VI)

Southwark Station Boiler Air-Flow Model Tests and Operation Results, by R. A. Lane, engineer, mechanical-engineering division, Philadelphia Electric Company, Philadelphia, Pa., and E. L. Morrison, staff engineering department, The Babcock & Wilcox Company, New York, N. Y. (48—A-26)

External Corrosion of Furnace-Wall Tubes, III: Further Data on Sulphate Deposits, and Significance of Sulphide Deposits, by R. C. Corey, supervising engineer, Combustion Research Section, U. S. Bureau of Mines, Pittsburgh, Pa., H. A. Grabowski, research engineer, and B. J. Cross, research engineer, research and development department, Combustion Engineering Company, Incorporated, New York, N. Y.

Methods and Instrumentation for Furnace Heat Absorption Studies: Temperature and Composition of Gases at Furnace Outlet, by Paul Cohen, fuel engineer, R. C. Corey, supervising engineer, Combustion Research Section, and J. W. Myers, U. S. Bureau of Mines, Pittsburgh, Pa.

Boiler Model Scenes and Flame Travel in the Southwark Boilers—Motion Picture

Fluid Meters

Coefficients of Discharge of Eccentric and Segmental Orifices, by S. R. Beitler, professor, and D. J. Masson, instructor, department of mechanical engineering, The Ohio State University, Columbus, Ohio

Critical Flow Through Sharp-Edged Orifices, by Joseph A. Perry, Jr., design department, Republic Flow Meters Company, Chicago, Ill.

Air-Flow Through Small Orifices in the Viscous Region, by Henry R. Linden, Institute of Gas Technology, Technology Center, Chicago, Ill., and Donald F. Othmer, professor, head, department of chemical engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. (48—A-93)

Effect of Temperature on Metals (I)—Gas Turbine Power (VI)—Metals Engineering (IV)

Hot-Spin Tests of Bladed Jet-Engine Rotors, by H. B. Saldin and P. G. DeHuff, Jr., section engineers, aircraft gas turbine division, Westinghouse Electric Corporation, South Philadelphia, Pa.

Comparison of High-Temperature Alloys Tested as Blades in a Type B Turbosupercharger, by William C. Stewart, superintendent, metallurgical laboratory, and H. C. Ellinghausen, metallurgist, U. S. Naval Engineering Experiment Station, Annapolis, Md.

Applicability of Ceramics and Ceramals as Turbine Blade Materials for the Newer Aircraft Power Plants, by A. R. Bobrowsky, aeronautical research scientist, National Advisory Committee for Aeronautics, Cleveland, Ohio

Changes in Internal Damping of Gas Turbine Materials Due to Continuous Vibration, by G. B. Wilkes, Jr., metallurgist, Thomson Laboratory, General Electric Company, West Lynn, Mass.

10:00 a.m.

Textile (I)

The Instron Tensile Tester, by Harold Hindeman, president, and George S. Burr, vice-president, Instron Engineering Corporation. Quincy, Mass. (48—A-68)

The Present Status of Bonded Fabrics, by Raymond Seymour, research special products, Johnson and Johnson, New Brunswick, N. J., and George Schroder, head, development department, H. H. Frede Company, Chattanooga, Tenn. (48—A-65)

The Warner and Swasey Weaving Machine, by Myron S. Curtis, director of engineering, Warner and Swasey Company, Cleveland, Ohio

2:00 p.m.

Textile Luncheon

Luncheon will be preceded by cocktail hour at 12:00 noon

Presiding: W. Arthur Smith, Jr., engineering sales manager, The Carlyle Johnson Machine Company, Manchester, Conn.

2:30 p.m.

Effect of Temperature on Metals (II)—Power (X)—Metals Engineering (V)

Cyclic Heating Test of Main Steam Piping Joints Between Ferritic and Austenitic Steel at Sewaren Generating Station, by H. Weisberg, mechanical engineer, Public Service Electric and Gas Company, Newark, N. J.

Report on Graphitization Studies on High-

Temperature Welded Piping of the Philadelphia Electric Company, by J. B. Abele, senior engineer, Philadelphia Electric Company, Philadelphia, Pa., and A. E. White, director, Engineering Research Institute, University of Michigan, Ann Arbor, Mich.

Textile (II)

The Challenge Facing Colleges Today, by Kenneth R. Fox, president, Lowell Textile Institute, Lowell, Mass.

Electromechanics in the Textile Industry, by Fred D. Snyder, sales engineer, Westinghouse Electric Corporation, Boston, Mass.

The Strain Gage as Applied to Loom Study, by Victor Sepavich, research engineer, Crompton and Knowles Loom Works, Worcester, Mass.

Electrostatic Air Cleaning in the Textile Industry, by R. L. Lincoln, precipitron section engineer, Sturtevant Division, Westinghouse Electric Corporation, Boston, Mass.

ASME Oregon Section Host to Society at 1948 Fall Meeting, Held at Portland, Ore., Sept. 7–10, 1948

HYDROELECTRIC power and the wood industries were among topics of interest to the industrial Northwest discussed at the ASME 1948 Fall Meeting held at Reed College, Portland, Ore., Sept. 7–10, 1948. Plant trips, scenic tours, and social functions rounded out an enjoyable program.

At the opening luncheon members and guests were greeted by several prominent representatives of the host city. W. A. Bowes, city commissioner, welcomed the group to the City of Roses. In his remarks he explained the reasons why Portland was so proud of its reputation as a "city of homes" and reviewed its progress during recent years. In 1939 the Portland metropolitan area included approximately 400,000 persons and in less than 10 years that number has increased to over 600,000 persons.

E. B. MacNaughton, president of Reed College, welcomed the ASME to Reed College campus and explained the policies of this college. By providing a highly individual approach to higher education and by striving to be "not the biggest, but the best" this school has attained national recognition.

Industries of Portland

An outline of Portland's industry was furnished those attending the Tuesday luncheon by Chester K. Sterrett, manager of the Industries Department of the Portland Chamber of Commerce. Mr. Sterrett listed Portland's outstanding industries in the order of their importance as being: (1) lumber; (2) foods; (3) ferrous metalworking; (4) nonferrous metalworking; (5) textiles; and (6) chemical.

The scheduled luncheon speaker was J. Calvin Brown, vice-president, ASME region VII, who spoke on "Milestones in ASME Service." In his introduction of prominent officers of the Society, Mr. Brown reviewed their personal accomplishments.

During the Wednesday luncheon, L. J. Fletcher, member ASME, director of training and community relations, Caterpillar Tractor Company, Peoria, Ill., pleaded with the engineers to aid in preserving the American way of life in his talk on "The Engineer's Stake in His Community." Misunderstanding on an international level of our own democracy, and in our labor and industry relations creates an urgent need for the engineer to assume responsibility in the field of developing understanding. Because engineers possess in common an analytical or logical way of thinking they are peculiarly fitted to deal with the problems now facing society. Mr. Fletcher stated that it is imperative that the individual engineer work in his own community to bring about understanding since the community is the real unit of society in the world and society is simply the sum of its communities.

One of the high lights of the meeting was the informal cocktail hour and the dinner held Wednesday evening at beautiful Timberline Lodge, situated 5000 feet up on Oregon's Mount Hood. Here, A. A. Groening, head of the physics department of Lewis and Clark College, Portland, Ore., told the assembled guests that the extension of human life from decades to centuries may follow if radioactive tracers solve the mystery of why man becomes infirm in old age. Not only infirmities of old age, but cancer, heart disease, infantile paralysis, and the common cold will yield to control through the use of radioactive isotypes, Dr. Groening predicted.

Engineering a National Economy

The guest speaker at the Thursday luncheon, W. Walter Williams, chairman of the Committee for Economic Development and president of Continental, Inc., Seattle, Wash., was introduced by F. B. Lee, chairman of the ASME Puget Sound Section. Mr. Williams, in his talk, "Engineering a National Economy," reported the basic principles in sound engineering practice as being: (1) getting the facts; (2) interpreting those facts as carefully and intelligently as possible; and (3) bold, affirmative action based on those facts and an intelligent interpretation of them.

Because of the very nature of his profession, the engineer should readily understand the need to apply these same principles that are used to erect great dams, complicated machines, and huge factories to "erect an edifice even greater than any of these—a sound national economy."

Mr. Williams posed the question: "How do we go about engineering a national economy which will: (1) avoid violent boom-busts; (2) remain dynamic, productive, and increasingly beneficial to our society; (3) preserve our freedom; and (4) stabilize the world for peace." In answering this question, Mr. Williams explained the purpose and function of the Committee for Economic Development.

"The Committee for Economic Development (CED) was organized in 1942. It had a twofold purpose. The first was to stimulate employers throughout the country to study their respective businesses with the purpose of bestirring themselves into postwar activity to help avoid a threatened unemployment situation. The second purpose of CED was to engage in a program of research concerning the various parts of our economy in the hope that by studying the facts and interpreting them carefully, gradually a sounder economy might be evolved."

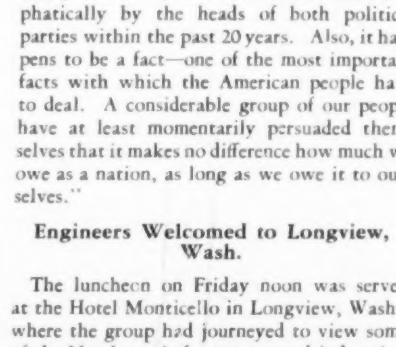
Need for Sound Economy

Acting as toastmaster at the Thursday evening banquet was Eugene Caldwell, Mem. ASME, vice-president and general manager of the Hyster Company, Portland, Ore. Dinner music was provided by Glenn Shelly and his string ensemble. In the featured address, "Engineering in an Era of Big Science and Big Government," Wilson M. Compton, president of Washington State College, called for measures to strengthen the national economy and give impetus to new industry and free enterprise by formulating a "forthright plan for the orderly payment of the national debt" and "a national system of income taxation which will enable the government to pay its debts and pay its way." The Federal income tax, together with the growing national policy of lending and spending, is the principal source of "big" government, Dr. Compton said. The income tax has made possible the financing of two big wars, the "arsenal of democracy," and a gigantic national debt.

"Government as well as households, over a reasonable period of time, must live within their income. That is not a political statement, or if it is, it is a statement made emphatically by the heads of both political parties within the past 20 years. Also, it happens to be a fact—one of the most important facts with which the American people have to deal. A considerable group of our people have at least momentarily persuaded themselves that it makes no difference how much we owe as a nation, as long as we owe it to ourselves."

Engineers Welcomed to Longview, Wash.

The luncheon on Friday noon was served at the Hotel Monticello in Longview, Wash., where the group had journeyed to view some of the Northwest's foremost wood industries. Addresses of welcome were made by C. C



A. A. GROENING ADDRESSING DINNER MEETING AT TIMBERLINE LODGE

Tibbetts, mayor of Longview, and by H. H. Martin, president of the Longview Chamber of Commerce. Toastmaster for the occasion was Perry Culp, assistant director of public relations, Long-Bell Lumber Company, Longview, Wash.

A. H. Labsap, Longview Water Commissioner, told his audience that Longview, celebrating its 25th anniversary, is one of the few cities that has had a planned and orderly development. In 1923, Mr. Long, founder of the Long-Bell Lumber Company, started this city that was to become an outstanding industrial center.

Salmon Bake

At the Friday evening Salmon Bake, R. H. Rawson, consulting timber engineer, Portland, Ore., served as the official representative of Paul Bunyan, mythical ruler of the Northwest lumber industry for nearly a century.

An interesting feature of the program was a review by W. T. Robertson, Mem. ASME, and design engineer for the Humble Oil and Refining Company, Houston, Texas, of his experiences in the days of Longview's birth. Mr. Robertson was the first engineer employed by Mr. Long to lay out the city of Longview.

Technical Sessions Open Tuesday

The technical sessions opened on Tuesday with a joint session of the Power and Hydraulic divisions. Walter Giger, Mem. ASME, engineer, Allis-Chalmer Manufacturing Company, Milwaukee, Wis., told the group that studies of the application of gas turbines to locomotives have shown their feasibility for high-speed passenger trains. He described the 3000-hp oil-burning gas-turbine locomotive which permitted speeds up to 150 mph without sacrificing safety because of its lowered center of gravity, reduced weight, and streamlining.

One gas-turbine locomotive is in operation and a few more are under construction in the United States and abroad. Two being built for Bituminous Coal Research, Inc., are coal-burning and cheaper to operate than oil burners in so far as fuel is concerned.

In a second paper, repairs made at the Kanawha Valley Power Company hydroplants on the Kanawha River near Charleston, W. Va., were described. Approximately five tons of welding rod was used in repairing cavitation of 646 square feet of the adjustable-blade turbines af London, Marmet, and Winfield. These major repairs were carried on during low-water periods over the last four years and were recently completed.

Mechanisms of Cavitation

In the last paper presented at this session, Aladar Hollander, Mem. ASME, associate professor, California Institute of Technology, Pasadena, Calif., discussed "Laboratory Investigations of the Mechanisms of Cavitation." If, under normal flow conditions, the pressure is reduced below the vapor pressure of the liquid, cavities are formed which are filled with vapor and dissolved gases. The formation of cavities not only renders the usual flow equations invalid but also frequently fixes the maximum possible rate of discharge by preventing further reductions in pressure, adversely affects the flow pattern, and results in a loss of energy, and creates an adverse hammering effect when the fluid carries the cavities into regions of higher pressure and the vapor abruptly changes back to the liquid state. Mr. Hollander reviewed laboratory investigations conducted to analyze the mechanisms of cavitation in an attempt to reduce its effect.

DISCUSSING MATERIAL FOR THE EDUCATION SESSION AT THE ASME FALL MEETING

(*Left to right*: B. T. McMinn, head of the mechanical-engineering department, University of Washington, Seattle, Wash.; J. Calvin Brown, vice-president ASME Region VII; S. H. Graf, director of Engineering Experimental Station, Oregon State College, Corvallis, Ore.; and Linn Helander, vice-president ASME Region VIII.)

Hydropower Symposium

The second session of the Hydraulic and Power Divisions, held Tuesday afternoon, featured a symposium on "Hydropower and the Northwest."

The problems of using the water of the Columbia River and some of the possible solutions were reviewed by Col. O. E. Walsh, district engineer, U. S. Corps of Army Engineers, Portland, Ore., in his paper, "The Proposed Program for the Regional Development of the Columbia River." In the development of the Columbia River Basin emphasis is being placed on necessary flood control with serious consideration being given to the development of power in connection with this control.

Paul J. Raver, Bonneville Power Administrator, Portland, Ore., in a discussion which followed, said that Bonneville and Grand Coulee Dams, furnishing power to produce about half of the nation's dwindling supply of primary aluminum, are of major significance to the growing economy and future security of the United States.

An additional primary aluminum capacity, above that existing in 1948, of between 1 million and 2 million tons will be required by 1960 to meet the estimated demand. Between 2 million and 4 million additional kw of power capacity will have to be built to provide the necessary power and it is expected that the government will have to supply most of the additional requirements, Dr. Raver explained.

At the same session Kenneth G. Tower, senior hydraulic engineer, U. S. Army Corps of Engineers, Portland, Ore., presented the paper "McNary Hydroelectric Plant—Preliminary Design." McNary Dam, now in the stages of final design and awarding of initial construction contracts, will be a worthy representative of the mighty Columbia River.

This hydroelectric plant will have a 980,000-kw capacity. The dam, 90-ft high, will have an over-all length of 8300 ft. A powerhouse 1350 ft long will contain fourteen 280-in. diameter Kaplan-type 6-blade propeller runners rated mechanically at 111,300 hp.

The maximum load on the turbine thrust bearings will approximate $3^3/_4$ million pounds. Generators will be rated at 73,684 kva at 0.95 power factor and 85.7 rpm, and specifications will require their safe continuous operation at 15 per cent overload.

Design and general layout of the powerhouse were based on detailed studies in which the generating station was analyzed as integrated in a number of different assumed power systems, considered to represent requirements which will be imposed on this project.

Katy Gas Cycling Plant

At the petroleum session, also held Tuesday afternoon, W. T. Robertson, Mem. ASME, design engineer of the Humble Oil and Refining Company, Houston, Texas, presented a paper, "Construction of Katy Gas Cycling

Plant." H. N. Stamper, assistant chief engineer of the same company, was co-author of the paper.

Expansion of the Katy Gas Cycling Plant, situated 25 miles west of Houston, Texas, and one of the world's largest plants of its type, will result in increasing the propane recovery from approximately 30 to 80 per cent of the hydrocarbons contained in the gas. Construction of the new propane-recovery units was revealed as a further step in the titanic engineering and construction project, begun a month before Pearl Harbor, which enabled the Katy plant to deliver over three million barrels of high-octane gasoline to the air forces.

Wood Industries Session Popular

Among the sessions held Wednesday morning was the first session of the Wood Industries Division. The first paper, "Experiments With Mobile Equipment," prepared by Adolph Zwald, chief engineer, Hyster Company, Portland, Ore., was presented by Paul Brainard, design engineer, with the same company. It was reported that although quite a number of experiments in the field of tractor logging have been made involving considerable expense, none showed sufficient improvement to warrant a major change in the last ten years.

The purpose of the tests discussed was to determine the advantages of wider and longer tracks, sometimes referred to as improved flotation. Wider tracks on an experimental unit would practically support their load on the top of the ground whereas the narrower or standard tracks would sink down into the mud. On tractors, however, the standard 24-inch-wide tracks would sink down to firmer ground quickly to secure sufficient traction to move the load whereas the experimental 32-inch-wide tracks stayed on top of the ground and slipped in the mud.

Phil Grabinski, manager, skyhook department, Pointer-Willamette, Portland, Ore., presented the second paper, "Skyhook—A New Aerial Cableway Means of Transportation." Mr. Grabinski, in pointing out the main differences between the skyhook aerial cableway and regular cableway systems, showed how movement of the car was obtained by traction sheaves gripping a stationary cable, and how the car passed the main cable-supporting equipment.

Although designed originally for the logging industry, the skyhook is finding application in such other fields as construction, ship loading, sugar-cane harvesting, and passenger transportation.

Aircraft Servomechanisms

The paper, "Attentuation—Phase Frequency Analysis as Applied to Servomechanisms for Airplane Control Surfaces," was presented by James J. Rahn, research engineer, Boeing Aircraft Company, Seattle, Wash., during the Wednesday morning session of the Aviation Division. Mr. Rahn said that servomechanisms can be analyzed by the attenuation-phase method and explained this by describing a single-time constant system and a two-time constant system and combination of these two.

The criteria for stability and performance, the use of constant amplification and constant phase angle contours, and the relationship between a closed- and open-cycle system were also explained.

Materials Handling Developments

A third Wednesday morning session was that of the Materials Handling Division. Palletless materials handling was discussed by S. E. Farmer, engineer, Hyster Company, Portland, Ore. By the use of a hydraulically actuated load-grab attachment recently perfected at Hyster, certain materials may be moved by lift trucks without the use of pallets. Savings are thus made by eliminating expenditures for pallets and by reducing the handling operations.

John R. Diffenbaugh, engineer in charge of production control, Mixermobile Manufacturers, Portland, Ore., told of the development of the "Wagnermobile Fold-a-Way Lift." This versatile lift truck can handle not only packaged material by using conventional front-forks, but also bulk material by replacing the forks with a scoop.

During the same session, Clay T. Colley, Mem. ASME, consulting engineer, Quinton Engineers, Ltd., Los Angles, Calif., described "the largest and most complete materials-handling project probably ever attempted in the world." The title of his paper was "Materials Handling as Applied to Large Naval Operations."

Mr. Colley said that the United States Armed Forces did a better job of engineering planning than the enemy and one of their main assets was the planning for materials and their proper handling. "Materials handling did not win the war all by itself, but it was one of the strongest links in the chain of events that led to the final victory.

Engineering Training

The need for a broadened fundamental training program, rather than a highly specialized one for the undergraduate student engineer, was emphasized during the Wednesday afternoon session of the Educational Committee, by Raymond T. Ellickson, professor of physics and associate dean of the graduate school, University of Oregon, formerly of Reed College.

In speaking of the liberal-arts college as a training ground for engineers, Mr. Ellickson described the program which Reed College and 11 other liberal-arts colleges have undertaken with the Massachusetts Institute of Technology. This provides for a three-year liberal-arts course, followed by two years at M.I.T., and the award of the arts and engineering degrees simultaneously at the end of five years.

College-industry relations with particular reference to the placement and orientation of mechanical-engineering graduates were discussed at the same session by S. H. Graf, Fellow ASME, head of the mechanical engineering department and director of the Engineering Experiment Station, Oregon State College, Corvallis, Ore.

Because of the broader experience and outlook of the veteran graduate, Mr. Graf advised a more intensive training schedule and earlier granting of responsibility wherever this is possible.

B. G. DICK, GENERAL CHAIRMAN OF THE ASME 1948 FALL MEETING

B. T. McMinn, professor of mechanical engineering at the University of Washington, Seattle, delivered a third paper at the Wednesday education session. In his paper, "It is Our Job," Mr. McMinn recommended that a broader basic training be provided engineering students. If the curricula were not so restricted to scientific and technical courses, a more capable engineer and a better citizen would be graduated.

Stainless Steel and Light Metals

A second session held Wednesday afternoon was that sponsored by the Metals Engineering Division. W. B. Kirby, engineer, Electric Steel Foundry Company, Portland, Ore., discussed the three classifications of stainless steel. Emphasis was placed on the characteristics of the nonhardenable austenitic group and the value of molybdenum in corrosion-resisting analyses. The problem of chromium in solution was one of those reviewed in discussing the care necessary to produce sound stainless steel castings.

In opening the light-metals symposium, W. A. Pearl, Mem. ASME, director of the Washington State College Institute of Technology, told of research in the field of light metals of this institution. Many of those techniques of design and fabrication, using aluminum and magnesium, developed at W.S.C. were now commonplace in industry, he said.

Attention was called to some of the unusual physical characteristics of aluminum and magnesium alloys by E. B. Parker, Mem. ASME, director, W.S.C. division of industrial services. Mr. Parker pointed out how the unusual properties of these alloys could be used to advantage and how their shortcomings could be overcome through proper design and fabrication methods.

Eugene Cramer, W.S.C. metallurgist, in describing the basic principles of magnesium founding, reported that magnesium alloys have a higher activity, but lower thermal properties, density, and solidification shrinkage than nearly all other common casting alloys. Magnesium foundry practices differ in such ways that the effects of these properties may be utilized or restrained.

In discussing the welding processes used on aluminum and magnesium, A. R. Hard,

WSC research engineer, correlated the strength of each weld specimen with characteristics of the alloy and the process, equipment costs, and process control, preweld and postweld treatment. Examples were shown which demonstrated the possibilities of combining different alloys and processes in order to use their best characteristics.

Management Guidance

Among the papers featured at the Thursday morning session of the Management Division was that of W. B. Rice, chief statistician, Plomb Tool Company, Los Angeles, which reviewed an application of control-chart technique to business estimating. Mr. Rice considered the problem facing the businessman who wishes to estimate future business volume and analyzed problems of statistical inference.

Wood Industries Research

H. E. Cox, manager, Willamette Valley office of West Coast Lumberman's Association, Eugene, Ore., during the Thursday morning session of the Wood Industries Division, stressed the fact that wood-industries research directed toward the development of new markets, new methods, and new inventories is essential to the economic welfare of the great lumber states of Oregon and Washington. The two thirds of the tree left in the woods or converted to mill waste must be utilized and that can be accomplished only through research.

There is much to be done in the long march toward higher-quality lumber obtainable at lower cost, Peter Koch, Jun. ASME, assistant to president, Stetson-Ross Machine Company, Seattle, Wash., reported at the same session. "Machine selection is no longer a matter of obtaining a machine with the lowest initial cost, but rather a problem of balancing tooling investment against quality and rate of output."

"Progress and Problems in Better Forest Utilization in the Pacific Northwest" was the subject of a paper presented by O. H. Schrader, Jr., associate professor, College of Forestry, University of Washington, Seattle, Wash. Mr. Schrader revealed that new industries and methods of converting forest and manufacturing leftovers are important developments in the Pacific Northwest. The finding of economic methods of converting mill and wood waste to marketable products has assumed major importance.

According to C. J. Tilford, forester, and L. H. Reinoke, technologist, Forest Products Laboratory, Madison, Wis., operators of thousands of small sawmills will be able to adjust their mills to greater operating efficiency as a result of investigations now being carried on at the Laboratory. This fact was disclosed by the presentation of their paper, "Investigations of Energy Requirements for Circular Insert-Point Headsaws." They hope that by correlating results obtained from tests now being run, sawmill power requirements can be predicted for any species.

The last paper presented, "Results of Accelerated Tests and Long-Term Exposures on Glue Joints in Laminated Beams," was prepared by T. R. Truax, technologist, and M. L. Selbo, chemical engineer, Forest Products Laboratory, Madison, Wis. It described a rapid method developed at the U. S. Forest Products Laboratory for determining the durability of glue joints in laminated beams, based on the principle that shrinking and swelling of laminated members produce stresses that cause checking of wood and failure of glue joints.

Technical Tours and Trips

Four interesting and diversified tours were made which permitted visitors to inspect outstanding industries of the Columbia Basin, Bonneville Dam, and Timberline Lodge.

The host on Tuesday evening was the Reynolds Metals Company. Their modern aluminum reduction plant, located six miles east of Portland, permitted visitors to the area to witness an outstanding example of the light-metal industry that has grown so rapidly in Oregon and Washington during the last eight years.

On Wednesday evening, members and guests journeyed to Timberline Lodge, located at the timberline of Oregon's 11,245-ft Mt. Hood. Here dinner was served amid the spectacular surroundings of the world-famous lodge.

Wood industries were featured in the Friday trip to Longview, Wash., 50 miles down the Columbia River from Portland. The morning tour of the Long-Bell Lumber Company, permitted a close inspection of one of the world's largest sawmills and its integrated utilization factory where wood products ranging from bird houses to sections for prefabricated houses are produced. The host during the afternoon was the Weyerhaeuser Timber Company. Their extensive operations, designed to utilize all of the tree, permitted members to witness a plywood plant, with its hydraulic barker in operation and a modern West Coast pulp mill.

Reported by PAUL D. CHRISTERSON.[1]

[1] Secretary, ASME Oregon Section, Jun. ASME.

Materials Handling Show to Have ASME Sponsor Technical Program

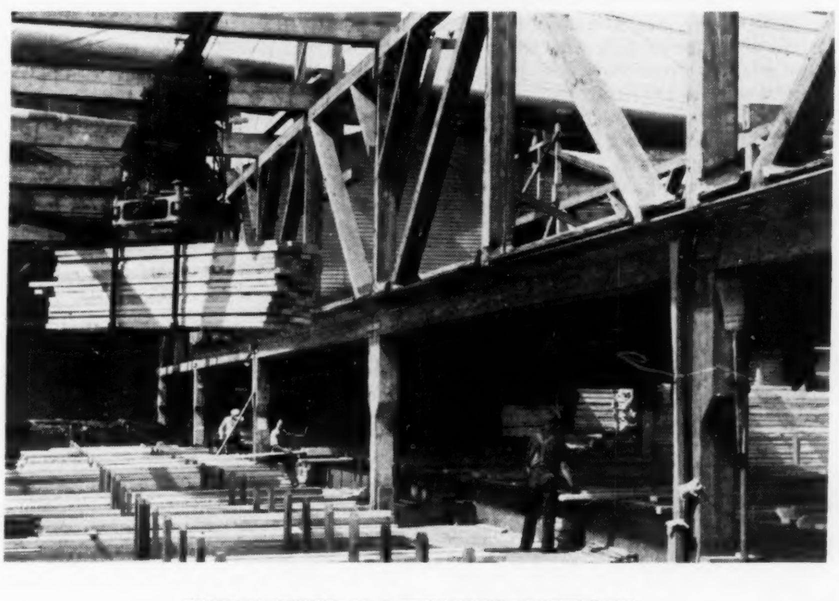
THE technical program of the third National Materials Handling Show to be held at Convention Hall, Philadelphia, Pa., Jan. 10–14, 1949, will be sponsored by the Management and Materials Handling Divisions of The American Society of Mechanical Engineers. The Materials Handling Institute is arranging the banquet.

The show, which is expected to be one of the five largest industrial expositions in 1949, will emphasize the need for greater efficiency in handling to reduce production and distribution costs, and the greater use of existing facilities for storage.

The current importance of materials handling as part of the industrial costs structure is evidenced in the fact that one quarter of every dollar of industry's pay roll is spent for materials handling. Another factor is the draft which may be expected to take from industry many young men who normally are employed for handling tasks.

Among the many types of equipment to be exhibited will be hand trucks, lift trucks, conveyers, hoists, monorails, portable elevators, stacking units, cranes, tractors, trailers, fork trucks, skids, and pallets, and their respective accessories.

Serving as general chairman of the technical-program committee for the ASME is Curtis H. Barker, Jr., vice-president, Pallet Sales Corporation, and chairman of the ASME Materials Handling Division. H. B. Maynard, president, Methods Engineering Council, is representing the ASME Management Division on the committee.



SORTING LUMBER AT A WEST COAST LUMBER MILL

(During the ASME Fall Meeting, members visited the Long-Bell Lumber Company and the Weyerhaeuser Timber Company, where they observed modern techniques designed to utilize the whole tree.)

IIR Division National Conference Contributes to Success of 1948 Instrument Fair

THE annual conference of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers was held at Convention Hall, Philadelphia, Pa., Sept. 13-14, 1948, as a part of the technical program of the 1948 American Instrument Fair. An enthusiastic crowd of 14,000 engineers and physicists attended the meetings, technical sessions, luncheons, and dinners which composed the program.

The fair was sponsored jointly by the Instrument Society of America, the Instruments and Regulators Division of the ASME, the American Institute of Physics, and the American Institute of Electrical Engineers. Success of the ASME program was due in large part to the excellent co-operation of the ASME Philadelphia Section. The heart of the fair was an instruments exhibit composed of 200 exhibitors whose booths were crowded each day from opening to closing time. Audiences well in the hundreds attended more than 19 technical sessions. More than 40 papers and lectures were presented.

Two ASME Sponsored Sessions

Among the many sessions at the fair, the Instruments and Regulators Division sponsored two technical sessions: the first included a paper by A. J. Hornfeck, entitled "Response Characteristics of Resistance-Thermometer Elements," and a paper by O. C. Brewster on "Bourdon Tubes in 5000-Psi Pressure Transmitters," with B. J. Wilson, chairman of the meeting. The second session presented "Laboratory Analogs for Electric Furnaces," by R. M. Hutchinson and S. P. Higgins, Jr., and "Functional Flexibility in Process Control," by F. H. Trapnell, with R. L. Goetzenberger chairman of the meeting.

The able discussion of resistance-thermometer elements by Mr. Hornfeck presented analysis and data on measuring lag—a subject of great importance in view of the greatly increased use of the resistance thermometer in applications where accuracy, narrow spans, and speed of response are essential. Mr. Brewster brought out critical analytical thought in discussing the design of Bourdon-type pressure transmitters applied to measurements in what has previously been considered a high-pressure range. The possibilities in using force-balance design to accomplish a compact design were emphasized.

The Hutchinson and Higgins paper was well presented by Mr. Hutchinson in showing that the industrial electric furnace with on-off (two-position) control can be duplicated simply and with reasonable engineering accuracy in the laboratory by means of electrical RC mesh networks. The role of the thermocouple measuring lag was included and results compared between actual and analog tests. Mr. Trapnell's talk was directed to instrumentation in chemical-processing plants, bringing out requirements and methods for obtaining flexibility in arranging control instruments.

President Bailey Addresses Luncheon

The welcoming luncheon brought together several hundred engineers for lunch; actually, however, Pres. E. G. Bailey was the attraction. President Bailey introduced an intriguing theme into his discussion, the importance of instrumentation to industry, and the impact of world political and economic affairs on the engineer. Mr. Bailey was introduced by the toastmaster, D. Robert Yarnall, past-president ASME, who reviewed the leading part President Bailey played in setting the stage for present-day instrumentation.

The banquet was sponsored by all participating societies and was attended by five hundred instrumentation engineers and physicists. Besides a well-planned banquet with music, entertainment, and elegant decor, the main speaker was Frank Totton of Chase National Bank, whose subject was "America Tomorrow." Those fortunate in attending were given an authoritative foresight into the future possibilities of the American way of life.

Reported by D. P. ECKMAN.[2]

[2] Professor, Sibley School of Mechanical Engineering, Cornell University, Secretary, ASME Instruments and Regulator Division.

Aircraft Design and Turbojets Discussed at ASME 1948 Aviation Conference

A SUCCESSFUL Aviation Conference, sponsored by the Aviation Division of the ASME, in co-operation with the ASME Dayton Section, was held in Dayton, Ohio, on Sept. 20-21, 1948.

Except for the technical sessions, the ASME Dayton Section planned the two-day program.

An illuminating paper for engineers started the Monday morning meeting. J. M. Christensen, research psychologist of the Aero Medical Laboratory at the Wright-Patterson Air Force Base, discussed "A Method for the Analysis of Complex Activities and Its Application to the Job of the Arctic Aerial Navigator" (48—AV-2). Data were gathered and analyzed to determine what new equipment or what changes in present equipment would result in the greatest improvement; what is the optimal layout of such equipment with regard to convenience, importance, frequency of use, and reduction of fatigue; and what are the minimum crew requirements that will insure satisfactory navigation of aircraft. Techniques were perfected to obtain the necessary data with the minimum of effort. The sampling method used can be extended to include the duties of all air-crew personnel.

Of interest was a proposal for a new measure of time. Each air-crew member is responsible for about 1500 pounds additional weight for the airplane. It is therefore suggested that one minute is worth approximately 25 pounds ($1500 \div 60$). In other words, provided other things are equal, this ratio provides a rough guide for estimating the value of new equipment and the design of air-crew work places in terms of weight liability.

High-Speed Escape

In "Cockpit-Design Problems of High-Altitude High-Speed Flight" (48—AV-1), J. E. Sullivan, director of the air-borne equipment division of the Bureau of Aeronautics, Navy Department, pointed out that operation of high-altitude, high-speed airplanes produces new problems in heating and cooling the cockpit, and providing escape methods for the pilot. For example, between sea level and 45,000 ft, direct solar irradiation on the cockpit enclosure varies from 150 to 450 Btu per hr per sq ft. For a fighter enclosure of 25 sq ft of exposed surface, and about 50 cu ft volumetric capacity, the temperature increase would be from 10 to 25 F. Outside air at 90 F jumps to about 144 F when inducted into the ventilating system of an airplane traveling at 600 mph.

It is felt that the conventional bail-out system to effect escape in an emergency is limited to approximately 300 miles per hour, otherwise the pilot may be seriously injured by the wind blast alone. In an interesting movie short, the effect of 300-mph wind on a man's face was shown. There was a continuous rippling of the facial skin with the ear "wagging" at an alarming rate.

The requirements for "Automatic Control of Turbojet Engines" (48—AV-3) were presented by C. S. Cody of the aviation gas-turbine engineering department of The Westinghouse Electric Corporation. When it is remembered that fuel controls, acceleration controls, and variable-area exhaust-nozzle controls have to be considered, the need for automatic control can be appreciated.

More Thrust Needed for Short Take-Off

"Thrust Augmentation as Applied to the Turbojet Engine" (48—AV-4) was the subject of Edward Woll's paper (Aircraft Gas Turbine Division of The General Electric Company). In aircraft driven by the turbojet engines, it is found that even though ample thrust is available for cruise and high-speed operation, thrust is not adequate to give the short take-off runs desired.

Those who attended the banquet enjoyed Col. E. A. Deed of The National Cash Register Company, Dayton, Ohio pinchhitting for C. F. Kettering, who was to act as toastmaster. Brig. Gen. S. R. Brentnall, Jr., deputy director of Research and Development of the Air Materiel Command, indicated the many factors encountered when designing aircraft for different climes, temperatures, humidity, sand, dust, salt, ice, and snow.

The inspection trip to the Wright-Patterson Air Force Base was extremely worth while to all those who went to see the static displays of aircraft as well as the displays of aircraft components.

The Dayton Section is to be congratulated on their excellent organization of a very fine meeting.

Reported by F. K. TEICHMAN.[3]

[3] Professor, New York University, Secretary, ASME Aviation Division.

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, B. H. EDELSTEIN, CHAIRMAN

Junior Members to Meet Informally at Annual Meeting

AT THE 1947 ASME Annual Meeting in Atlantic City, the Junior Committee held an informal meeting at which the work of the Committee and its first major project, the Junior Forum, were discussed. Twenty-one junior members and students were present. A brisk exchange of opinions established two points: (1) That the locus of interest of junior members is different from that of older members and ought to be reflected in junior-group organizations and in activities planned and conducted by junior members; and (2) that the Junior Forum has a definite function to perform and ought to be continued.

Since that meeting the validity of point (1) has been questioned many times, especially by junior members in some sections where no distinction is made in grades of membership and where juniors carry most of the section offices. It appears that the Junior Forum is a mischievous influence if it suggests to older members that junior members wish to remain apart from the body of the Society. Actually, the Junior Committee holds that the professional aims of junior members are those of the Society and that the Junior Forum should serve only to promote those aims.

Because the purpose and effect being produced by the Junior Forum is being questioned by some members of the Society, the Junior Committee has called a meeting of junior members who plan to attend the 1948 Annual Meeting to discuss informally the whole range of junior-member activities. Junior members are urged to attend this meeting.

On the agenda is a talk by Donald E. Jahncke, chairman, Junior Committee, in which he will tell about the work of the Committee and its future plans. B. H. Edelstein will tell about the job of editing the Forum. A general discussion will follow.

It is hoped that junior members will come prepared to exchange opinions and ideas on how junior members can best serve themselves and the Society.

Junior Committee Discusses Role of Junior Advisers

THE September meeting of the Junior Committee, held at Headquarters, Sept. 25, 1948, was preceded by the usual discussion of automobiles (Donald Jahncke, chairman, works for Mercury-Lincoln). This month's topic was automobile costs and how to keep a balance between rising prices of labor and materials and the selling price of the car. The meeting opened formally at 1:30 p.m. with Mr. Jahncke, C. H. Carman, G. B. Thom, J. B. Burkhardt, F. E. Reed, and A. F. Bochenek present. A. R. Mumford, vice-president ASME Region II, representing the officers of the Society, was also present.

Duties of Junior Advisers

Mr. Jahncke reported on the results of letters he had written to the vice-presidents in charge of the various regions to secure their recommendations for effective corresponding members of the Junior Committee. The next item of business concerned the junior advisers who sit on many of the standing committees of the Society. Philip Allen, who recently resigned from the Junior Committee because of the pressure of his work, had prepared a memorandum on the subject in which he recommended that junior advisers be given some work to do, and discussed some of the problems of the selection of the junior advisers. Mr. Mumford pointed out that he believed that, in general, it would be difficult to make the junior adviser the "leg man" of the committee but with his guidance it was developed that the junior adviser could be a valuable addition to any committee if his duties were:

1 To report the activities of his committee to the Junior Committee and to juniors, in general, through the Junior Forum.
2 To present junior opinion as indicated by letters to the forum and by the Junior Committee.
3 To answer criticism and inquiries from junior members.

As an example of the last, Mr. Mumford discussed the case of the junior member who resigned from the Society because he considered the voting procedure dictatorial. His presence on the nominating committee or a letter from the junior adviser on the nominating committee could make it clear to him that the process of electing the Society's officers has safeguards in every step to insure the selection of the best men to represent the Society without being dictatorial.

Study of ASME Committee Structure Suggested

Mr. Carman was instructed to secure from the Metropolitan Junior Group recommendations for junior advisers to serve on the Meetings, Professional Division, and Publications Committees. It was realized that junior members know little about the committees of the Society, the number of meetings which each holds, where they are held, and the subjects falling under the committee's jurisdiction. Mr. Carman was instructed to prepare a manual for the guidance of junior advisers dealing with those committees on which he had served. Mr. Burkhardt agreed to study the annual reports of the different committees to ascertain the statistics on the other committees. The general aim of these studies is to develop a more satisfactory procedure for securing junior representation with specific duties on the committees and to arrange a more suitable method of selecting the junior advisers. At present, because committee members stand their own travel and hotel expenses, the junior advisers are chosen from the Metropolitan Junior Group and it would be desirable to expand the area of selection where possible.

Informal Session at 1948 Annual Meeting

The status of the Junior Forum was discussed as well as the preparation of the first draft of a pamphlet similar to "It's Up to You," for the use of student members, which was prepared by Mr. Reed. It was decided to request a parlor for the use of the junior members during the Annual Meeting. The meeting continued with discussions of the aims of the Society, the objectives to be considered in setting up a program, registration of engineers, and similar topics not on the agenda, late into the afternoon, when the janitor warned the group to break up because the building was to be closed at 6:00 p.m.

F.E.R.

What Makes for Success in Engineering?

EARLY this year the Junior Section of the Engineering Society of Detroit sponsored a course of four lectures on the problems of professional development which concern the young engineer. Abstracts of the third and fourth lecture prepared for the Forum by Allen E. Peters, secretary, ESD Junior Section, follow. Abstracts of the first and second lecture were published in the October Forum.

Which Way Up?

By Thomas H. Vaughn[1]

DR. VAUGHN, in his opening remarks, stated that he was not an expert on success but that he did "unqualifiedly believe in success." If the topic for discussion meant which way up to success, then of course it would be necessary to define success.

Oftentimes money, fame, and position are considered the important hallmarks of success. Yet there are a large number of men who have achieved these but who are decidedly unhappy. It is important then, that the individual should define success in his own terms and set his sights to achieve it.

There are many factors which influence a man's career which are beyond his control:

[1] Director of Research, Wyandotte Chemical Corporation, Wyandotte, Mich.

luck, decisions of others (either arbitrary or soundly considered), and the condition of the country's business, but there is considerable freedom in the choice of profession a man enters. He may choose a position in the administrative field, in a technical field, in a nontechnical field, in development and design work, in production, in research, in sales, and in teaching. There are also a number of special fields which can profit by the application of engineering principles and background, public relations, advertising, purchasing, patent work, market research, and technical sales and service work.

The advantages and disadvantages of choosing big business, little business, federal or state service, education, individual business ventures (consulting, etc.) as the agency for success were discussed at some length. This is an important choice which must be made by the young engineer. The relation of this choice to the individual's definition of success is obvious.

On the subject of how to succeed, reference was made to "The Unwritten Laws of Engineering,"[2] which was written by W. J. King, director, School of Engineering, Cornell University, Ithaca, N. Y. Some of the principal points of this article were:

1 However menial and trivial your early assignments may appear, give them your best efforts. Do them so well and so fast that you either pass beyond them or have assistants assigned to you to perform them.

2 There is always a premium upon the ability to get things done. When the boss wants something, see that he gets it fast. It may be trivial but it may lead to something big.

3 Confirm your instructions and the other fellow's commitments in writing. There are ways of doing this without causing friction.

4 Don't be timid—speak up—express yourself and promote your ideas. Don't brood over things—straighten them out while they are small.

5 Before asking for approval of any major action, have a definite plan and program worked out to support it, but be flexible with the plan.

6 Strive for conciseness and clarity in oral and written reports.

7 Be extremely careful of the accuracy of your statements.

8 In all transactions, be careful to "deal in" everyone who has a right to be in on them.

9 Promises, estimates, and schedules are necessary and important instruments in a well-ordered business. Respect them.

10 Regard your personal integrity as one of your most important assets.

11 Be careful of your personal appearance.

The cases of two young engineers were cited where their decisions and timing had a decided influence on their success. The success of the first was definitely retarded by his impatience and his resignation from a promising position. The second man's success was greatly enhanced by discussing frankly with his supervisor, his interests and objectives which discussion lead to a transfer and promotion to a position he had always hoped for.

Opportunity comes knocking very often indeed in a man's life. A man can be deaf to the knockings of opportunity for years or he can answer these knockings in the wrong way a number of times and still have further opportunities in the future. Make the best decision you can in connection with job changes, and if it turns out poorly, there will be another opportunity at some later time. A wrong decision in this connection may be responsible for success at some time in the future.

[2] This paper was published in three parts in the May, June, and July issues of MECHANICAL ENGINEERING, pages 323–326; 398–402; and 459–462, respectively. Reprints are on sale at ASME Publication Sales Department, 29 West 39th Street, New York, N. Y., at 25 cents per copy.

Living Up to Your Achievements

By R. L. Goetzenberger

IN the final conference lecture, Mr. Goetzenberger summarized the subject matter of the preceding lectures and outlined the steps an engineer must take to develop and maintain a well-rounded professional status after a successful career is under way.

In order to promote personal achievement, all junior engineers should take an active part in professional societies. Such participation is important and valuable for a number of reasons. Professional societies:

1 Provide varied personal associations.

2 Motivate early outlets of executive abilities.

3 Link the junior engineer with the best element of his profession.

4 Encourage his working with his fellows for the advancement of the profession.

5 Provide access to and participation in conference groups.

6 Permit his participation in the prestige built up in group publicity.

The registration of professional engineers is another very worth-while objective for the young engineer. A professional man is one who renders professional advice to clients and establishes a relationship of trust and confidence with them. There is a legal concept of professional engineering, that of safeguarding life, health, and property, and promoting public welfare. A certificate of registration establishes that the holder knows how to apply the engineering knowledge he possesses. Mr. Goetzenberger emphasized the fact that engineers must be dedicated to the service of the people.

An engineer must also be aware of his civic responsibilities. He must be a citizen as well as an engineer. He must know his government because it is an essential part of business. Another important concept which was emphasized was that of a well-balanced life which includes play, the home, and faith, in addition to the job. The young engineer should develop habits of reading good books and publications. He should become interested in music or other cultural pursuits or hobbies in order to counterbalance the influences of work and to promote the enjoyable use of leisure time.

It is very important also that he get along with and "live with his neighbors" successfully and peaceably. To achieve this end requires about 40 per cent technology and 60 per cent diplomacy.

[3] Vice-President, Minneapolis-Honeywell Regulator Company, Washington, D. C. Mem. ASME.

Kansas City Juniors Report Active Season

WHILE the Forum has had no reports from the Kansas City Junior Group during the past season, the Group was by no means inactive. Under the stimulus of the ASME Junior Committee, junior members of the Kansas City Section reorganized the old prewar organization in October, 1947, and appointed L. H. Lundsted, chairman, and Dwayne C. Smith, secretary.

Membership in the group was open to members 33 years of age or under with the understanding that in 1948 only members under 30 would affiliate with the group.

Before the season came to an end, 36 juniors had joined the group and six meetings were held, and there was a general feeling that the group had successfully achieved its purpose of encouraging young engineers to meet together at social and technical events designed to provide engineering information and to develop a feeling of professionalism.

Book Review

American Free Enterprise

MAINSPRING: The Story of Human Progress and How Not to Prevent It, by Henry Grady Weaver. Talbot Books, 6432 Cass Ave., Detroit 2, Mich., 1947. Paper $5^1/_4 \times 7^3/_4$ in., illus., 236 pp., $1.

THIS book is one which junior engineers can read with profit. It tells the story of human progress from the American point of view. To counteract the picture of American life defined by those more familiar with foreign values than those which have influenced the growth of American democracy, the author stresses the positive side of American culture. He "concentrates on the doughnut instead of the hole."

The American standard of living has been a fascinating subject for scholars. Some have attributed it to our wealth of natural resources, some to a materialistic philosophy which it is said dominates American thinking, others to the virtues of our political philosophy and our system of free enterprise.

The truth seems to lie somewhere in the last two reasons, for Americans are not more ambitious or hard-working than other people of the world nor do they have more energy. Out of their political philosophy has come human co-operation and specialization of effort which made possible more effective use of the human energy. The application of this liberated energy to available natural resources is the key to American prosperity.

In developing this theme, the author shows how the will to create is a function of personal and political freedom and depends on moral creeds. In the pagan world, creative energy was stifled by the fatalistic outlook on life. It was Christianity with its doctrine of free will and the dignity of man which first gave men hope and unshackled their imaginations and made the American ideal of democracy a possibility.

In his sweep of the history of human progress, the author sheds light on epochs of history of particular interest to engineers. The golden age of the Saracen culture, which was contemporaneous with the Dark Ages in Europe, gave us the arabic numerals and much basic information on which our mathematics, astronomy, navigation, modern medicine and surgery, and scientific agriculture are based.

But the chief virtue of the book under review lies in its story of the rise of American industry and free enterprise. Many of us have pride in our country but cannot effectively define the basis of that pride. The American ideal of more and better things for more people can be easily justified and defended. This book tells how.

In the face of false foreign ideologies, what happens to the American way of life is the responsibility of each citizen. This book can be read with profit by junior engineers if only to burnish the weapons with which to counteract subversion of their cherished ideals.

Reviewed by DONALD E. JAHNCKE.[4]

New ASME Officers Elected by Letter Ballot

AS reported by the tellers of election, Edwin B. Ricketts, H. B. Oatley, and A. D. Blake, letters ballots received from members of The American Society of Mechanical Engineers were counted on Sept. 28, 1948. The total number of ballots cast was 8481; of these 159 were thrown out as defective.

	Votes For	*Votes Against*
For President		
James M. Todd.......	8306	16
For Regional Vice-Presidents—to serve 2 years		
A. R. Mumford.......	8302	20
Arthur Roberts, Jr.....	8301	21
Forrest Nagler........	8308	14
C. J. Eckhardt........	8304	18
For Director at Large—to serve 4 years		
J. A. Keeth...........	8312	10
R. A. Sherman........	8308	14

The new officers will be introduced and installed in office during the 1948 Annual Meeting of the Society to be held at the Pennsylvania Hotel, New York, N. Y., Nov. 28–Dec. 3, 1948.

Biographical sketches of the newly elected officers were published in the August, 1948, issue of MECHANICAL ENGINEERING, pages 709–712.

[4] Chairman, ASME Junior Committee, Jun. Mem. ASME.

ASME NEWS

L. M. Goldsmith Honored for War Services

THE President's Certificate of Merit for outstanding services during the war has been awarded to Dr. Lester M. Goldsmith, Fellow ASME; Melville Medalist, 1939; and chief engineer of The Atlantic Refining Company. The citation was presented at a ceremony held on October 14 at The Franklin Institute in Philadelphia.

The Certificate was awarded for service as a member of the Transportation Division, Office of Scientific Research and Development. This is the second time the Government has honored Dr. Goldsmith for his war services. In April, 1947, he was presented the decoration for Exceptional Civilian Service for his contribution to the installation of "Operation Pluto."

Local ASME News

ONE of the helpful suggestions contributed by members who took part in the Readers Survey of MECHANICAL ENGINEERING last year and the early part of this year was that something should be done about the ASME News Section. The common denominator of most of the comments was that too much space was being devoted to news of limited interest. More often than not the finger pointed to the monotonous page after page which repeated in strict alphabetical order after the manner of a ritual, what had happened in each of the active Sections and student branches. The order was important because the items were so numerous and it was a service to readers to guide them through the desert to the oasis which mentioned their own Section or branch.

The choice of photographs also came under censure. Photographs of members which tell no story but show them standing around stiffly waiting for the camera to catch them apparently have long since lost their appeal. So have shots that show student members assembled en masse. In house organs, in yearbooks, these photographs have a rightful place but if we interpret the survey correctly, ASME members would rather find something else in the rear pages of their journal.

Just as the high cost of living and the new look are symptomatic of a new order of things, so it is evident that the Society with its expanding membership has acquired broader interests. Patterns of service which were once good, are no longer suitable and a professional group intent on information and some insight into trends, grows impatient over local news already so well covered in Section newsletters and the publications of local engineering clubs and councils.

It was on the basis of these trends that in March, 1948, a substantial reduction was made in the News published about Sections and student branches. With the approval of the Regional Vice-Presidents, a further reduction is made in this issue. What remains is a table of those Section and student branches which held meetings during a previous month. These tables should serve as a record of activity and give officers some idea of how their scale of activity compares with that of otther ASME local organizations.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Central Indiana, Sept. 11. Picnic at Forrest Park, Nobleville, Ind., for members, their families, and friends. Attendance: 62.

Piedmont, Sept. 17. Speaker: Geo. C. Potter. Attendance: 70.

Southern California, Sept. 22. Speaker: Wm. F. Purcell. Attendance: 46.

Southern Tier. Sept. 27. Speaker: Prof. C. E. Mackey. Attendance: 65.

Student Branch Activities

Reports of the following ASME student branch meetings were received recently at Headquarters:

Alabama Polytechnic Institute, Aug. 16. Program: "Lubricating Oils," a movie. Attendance: 34.

Columbia University, Sept. 29. First meeting of school year. Attendance: 39.

Cooper Union (Day), Sept. 27. Opening meeting of school year. Attendance: 36.

Duke University, Sept. 28. Speaker: Prof. K. Boutwell. Attendance: 48.

Illinois Institute of Technology, Sept. 30. Speaker: William H. Oldacre. Attendance: 300.

Kansas State College, Sept. 23. New officers introduced. Speaker: B. B. Brainard. Attendance: 155.

University of Kentucky, Sept. 30. Speaker: Mr. Bryant.

University of Louisville, Aug. 12. Two films, "Jet Propulsion," and "The Telephone Hour." Attendance: 59. Aug. 14. Picnic at Clark County State Forest, Henryville, Ind. Attendance: 50.

University of Michigan, Sept. 29. Speaker: H. S. Walker. Attendance: 175.

Mississippi State College, Sept. 29. Opening rally of new school year. Attendance: 40.

University of Missouri, Sept. 23. Speaker: Dr. Scorah, chairman, mechanical-engineering department. Attendance: 44.

Missouri School of Mines, Sept. 16. Speaker: C. A. Rohlfing. Attendance: 275.

University of North Dakota: Sept. 29. Speaker: Dr. Abbott. Attendance: 50.

Polytechnic Institute of Brooklyn (Day), Sept. 28. First meeting of school year. Attendance: 63.

University of Tennessee, May 12. Election of officers for the coming season. July 28. Speaker: Prof. R. L. Maxwell, former employee at NACA, Cleveland, Ohio. Attendance: 12.

Wayne University, Sept. 23. Speakers: Glen Howell and Bob Brauburger. Attendance: 78.

ASME Sections
Coming Meetings

Atlanta: November 15. Y.M.C.A. Dining Room at 12:30 p.m. Luncheon Meeting, by Georgia Engineering Society.

November 27. Georgia Tech Dining Room at 6:30 p.m. Subject: Rubber and Its Properties, by John D. Morrow, United States Rubber Company.

Baltimore: November 22. Engineers Club of Baltimore at 8:00 p.m. Subject: Atomic Energy. Speaker: A. L. Baker, Kellex Corporation, New York, N. Y.

Central Indiana: November 19. Rose Polytechnic Institute Cafeteria at 6:30 p.m. Subject: Generalities, by P. C. Brown, head football coach, Rose Polytechnic Institute, Terre Haute, Ind.

Mechanical-Engineering Problems Encountered in the Design and Fabrication of Industrial Equipment, by Everett C. Gosnell, division manager, Chemical and Process Equipment Division, The Colonial Iron Works Company.

Cincinnati: November 4. Joint meeting with Engineering Council at 8:00 p.m. Subject: Sewage Disposal, by A. B. Backherms.

Fairfield County: November 8. Meeting of the General Committee of the Connecticut Section in Waterbury, Conn.

Kansas City: Date to be decided. Joint meeting with the Kansas State College student branch at Manhattan, or the Kansas University student branch at Lawrence, following a dinner. Program provided by the students.

Metropolitan: November 4. Materials Handling Division, Room 1101[1] at 7:30 p.m. Subject: Handling Bauxite Ore From Steamships to Railroad Cars, by Richard P. Toussaint, assistant engineer, New York Central Railroad Company.

November 4. Woman's Auxiliary, Room 1101, 1:30 p.m. Annual meeting and election of officers, followed by short talk, social hour, and refreshments.

November 9. Process and Metals Division, Room 502[1] at 7:30 p.m. Subject: A Look at the Synthetic Gasoline Picture, by Dr. Frank T. Barr, Esso Research Center, Harold V. Atwell, supervisor of fuels research, Texas Co., and Frank A. Howard, consulting engineer, Rockefeller Center.

November 16. Photographic Group, Room 1101,[1] at 7:30 p.m. Subject: What Makes a Successful Picture, by Basil Bels, photographer and lecturer.

November 18. Engineers' Forum, Room 1101[1] at 7:30 p.m. Subject: The Engineer on Vacation. Special Feature: Slides taken by George G. Hyde on his trip to the West Coast, commentary read by H. C. R. Carlson.

November 22. New Jersey Division, Elizabethan Room, Essex House, Newark, N. J. at 7:20 p.m. Speaker: Henry J. Taylor, nationally known radio commentator for General Motors over the Mutual Broadcasting System. Mr. Taylor will give his regular Monday evening broadcast over 500 stations from the Elizabethan Room.

November 23. General-Interest Meeting, Room 501[1] at 7:30 p.m. Subject: "Chemical Research and Every-Day Living," by Miss Arretta Lynch Watts, Public Relations Dept., E. I. du Pont de Nemours and Company.

[1] Engineering Societies Building, New York, N. Y.

Minnesota: November 3. St. Anthony Falls Hydraulic Laboratory. Subject: Experimental Design of Hydraulic Structures, by Dr. L. G. Straub, director, St. Anthony Falls Hydraulic Laboratory.

November 11. Joint Meeting with other engineering societies. Subject: Bell Telephone Company demonstration by Dr. Perrine.

Peninsula: November 9. Dinner Meeting. Subject: The Heat Pump, by Claud Erickson.

Philadelphia: November 10. Junior Meeting at Engineers' Club. Subject: Photography.

November 16. Professional Division Meeting, Room 314, Towne School University of Pennsylvania. Subject: Management Training, by Harry F. Gracey, training director, SKF Industries, Philadelphia, Pa.

November 22. Engineers' Club at 8:00 p.m. Subject: The Mechanical Engineer in the Process Industries, by Robert J. Short, chief engineer, The Procter and Gamble Company.

Schenectady: November 18. Place to be announced. Subject: World Trade, by W. R. Herod, president, International General Electric Company.

Southern California: November 3. California Institute of Technology, Mechanical Engineering Building at 7:30 p.m. Subject: Hydraulics of Pipe-Line Design and Construction, by Dr. Peter Kyropolous, California Institute of Technology, Pasadena, Calif.

November 5. Dinner Meeting at Dixie Barbecue at 6:30 p.m. Subject: Solving Problems of Design and Performance in Aircraft with Ultraspeed Photography, by Roy Wolford, supervisor of engineering photography, Northrup Aircraft Inc., Los Angeles, Calif.

November 10. Southern California Edison Building, Room 214 at 7:30 p.m. Subject: Performance Paramentation for Jet Engines, by E. J. Specht, General Electric Company, Los Angeles, Calif.

University of Southern California, Science D Barracks Building, Room 204 at 7:30 p.m. Subject: Present Needs of Modern Conveying Equipment by West Coast Industry, by H. R. Butler, mechanical engineer, Richard Wilcox Company.

California Institute of Technology, Mechanical Engineering Building at 7:30 p.m. Subject: Design of Large-Diameter Pipe for Transmission Lines, by Dr. Warren O. Wagner, California Institute of Technology, Pasadena, Calif.

November 16. Dinner Meeting at Rio Hondo Country Club at 6:30 p.m. Subject: A Solution for the Mass-Transportation Problem of the Los Angeles Metropolitan Area, by Dr. Henry A. Babcock, consulting engineer, Los Angeles, Calif.

November 17. California Institute of Technology, Mechanical Engineering Building at 7:30 p.m. Subject: Design and Manufacture of Hydraulic Equipment, by H. Arthur Price, mechanical engineer, The Department of Water and Power, Pasadena, Calif.

Southern California Edison Building, Room 214 at 7:30 p.m. Subject: Continuation of the Series—Management Problems in Industry and Their Method of Solution by the Mechanical Engineer. Open Forum.

November 23. University of Southern California, Engineering Barracks B, Room 105 at 7:30 p.m. Subject: Fundamentals of Hydraulic Torque Converters and Fluid Couplings, by Prof. Robert Manes, University of Southern California.

Washington, D. C. November 10. Gym and Clubroom of the Christian Heurich Brewery at 8:00 p.m. Smoker.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	211 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 33, MME, licensed, experienced design hydraulically driven machinery, rotogravure presses, special equipment; layout small processing plants, specifications, supervision of installation; estimating, procurement, and contracting. New York, N. Y., preferred. Travel occasionally. Me-345.

MECHANICAL ENGINEER, 30, BSME, 7 years'

(*ASME News continued on page 952*)

[1] All men listed hold some form of ASME membership.

experience rubber and plastics; last 2 years engineering complete plastics plants and equipment. Registered Ohio, prefers East, plant engineering or design. Me-346.

INDUSTRIAL ENGINEER, age 31, ME degree, experienced in plant layout, production planning and control, and maintenance in manufacturing plant. Will locate anywhere in the U. S. Me-352.

GRADUATE MECHANICAL engineer, age 28, single, 7½ years practice experience; mill engineering in pulp and paper; project and development in metal manufacturing equipment design and installation in smelter. Presently assistant engineer. Desires work with U. S. firm in South America. Me-353.

PROJECT OR PRODUCTION ENGINEER, ME, PE, 10 years' experience. Familiar with the design and volume production of small accurate metal assemblies and large special equipment. Sound knowledge mechanics and basic stress analysis. Interested in challenging position with opportunity for professional advancement Me-347.

MECHANICAL ENGINEER, 35, ME, MS, registered New Jersey, Pennsylvania. Broad administrative, design experience in process industry, utilities, marine. Desires permanent responsible supervisory position in machine development, design or plant engineering. Me-348.

MECHANICAL ENGINEER, Stevens Institute, PE in New Jersey. 12 years' experience plant engineering, power generation, maintenance, construction and budgetary control; with steel and chemical background. Presently employed as chief engineer. Desires responsible position in plant engineering or operation with opportunity for advancement. Prefers metropolitan area but will relocate. Me-349.

MECHANICAL ENGINEER, 20 years' supervisory experience engineering and production sheet metal and light machine products. Can supervise tool design, plant layout, production control, methods, and standards with other duties in small or medium-size plant. Me-350.

MECHANICAL ENGINEER, BS licensed, 26, single, desires permanent foreign position. Four years' broad experience, piping, heating, ventilating, plumbing power plants. Willing to learn, will start at bottom in permanent position. Me-351.

POSITIONS AVAILABLE

MANAGER OF ENGINEERING, 40-50, mechanical graduate, with broad power plant and machinery-design experience, to take charge of engineering division. $8000-$9000. New York, N. Y. Y-1522.

EXECUTIVE ASSISTANT, 30-35, mechanical graduate, with engineering, operating and application experience in rock-products field, to assist executive in building-materials field. $7500. East. Y-1527.

ENGINEERS, (a) mechanical engineers, graduates, with substantial mechanical production engineering experience. Production supervisory experience not acceptable. $6600; (b) machine designers, experience required. Specific educational background unimportant. Tool designers not acceptable. Up to $4800. Pennsylvania. Y-1530.

MECHANICAL OR CHEMICAL ENGINEER, 40-50, executive caliber, who has had some maintenance and construction experience in the chemical industry. Must be capable of taking complete charge of the maintenance and design for several plants. $10,000-$12,000. Pennsylvania. Y-1533.

MECHANICAL ENGINEER, graduate, with at least 6 years' practical mechanical-engineering experience, including 3 years in the field of solid-fuel combustion, for smoke abatement in air-pollution control. $4910. New York, N. Y. Y-1539.

JUNIOR TEST ENGINEERS, mechanical graduates, BS degrees, to test mechanical parts, adapt and develop test equipment and develop test equipment and accessories and keep and analyze records of test data. Connecticut. Y-1541.

MECHANICAL ENGINEERS, (a) with steel-mill operating and products experience, to survey small mills and prepare reports covering rolling practice, heating facilities, handling, shipping, storage, etc.; (b) with coal-cleaning experience to plan layouts of coal-cleaning equipment. $6000 up. New York, N. Y. Y-1542.

PRODUCTION ENGINEER, mechanical graduate with at least 10 years' general glass manufacturing experience, to take charge of plant production. Salary open. Venezuela. Y-1543.

INSTRUCTORS AND PROFESSORS in mechanical engineering, to teach fluid mechanics, heat transfer, air conditioning, etc. $3000-$5000. Central New York State. Y-1545.

ASSISTANT SALES MANAGER, 35-40, mechanical or chemical graduate, with about 10 years in sales engineering, dealing either with mechanical, molded or plastic parts. Should have a good record of obtaining business through making new contacts and starting new accounts. Duties will be to obtain additional business by personal contacts and selling; assist in developing and directing an adequate sales-promotion program; assist in guiding market research. $7000-$8000. Central New York State, with some traveling. Y-1547.

MECHANICAL ENGINEER with at least 5 years in refinery and powerhouse work, to supervise installation and operation of power and process equipment. $7200-$7800, plus all expenses. South America. Y-1548.

MECHANICAL ENGINEER with design and estimating experience covering crystallization equipment, to work with chemical engineers in developing flow sheets and equipment requirements, design crystallizers to suit customers, and supervise draftsmen on design and fabrication details including code requirements. Western Pennsylvania. Y-1553.

INDUSTRIAL ENGINEER, 30-35, graduate, with clerical methods and distribution-analysis experience, to analyze nonselling functions of retail merchandise distributors, including methods, cost data, etc. $3600-$4800. New York, N. Y., with traveling. Y-1558.

GENERAL SALES MANAGER, 40-45, mechanical graduate, with process control and equipment experience, to take charge of sale of water-conditioning equipment. $7500, plus bonus. East. Y-1560.

MECHANICAL ENGINEER, 30-40, with at least 7 years' experience rating heat exchangers, to select sizes, prepare specifications, tabulate test data, etc. $5200-$6500. Western New York State. Y-1582.

INDUSTRIAL ENGINEER, junior, with some experience in time study and systems planning, preferably in retail-store operations. Will operate under supervision. $3900-$4800. New York, N. Y. Y-1597.

MECHANICAL OR INDUSTRIAL ENGINEER, not over 42, graduate, with considerable experience in materials handling. It involves both materials and equipment with problems in conveyerizing, pallerizing and transportation. To $6600. Some traveling. Pennsylvania. Y-1598.

CHIEF MECHANICAL ENGINEER, 35-45, with electronic manufacturing experience, to supervise draftsmen, production engineers, and work with designers in expanding output of television and radio equipment. $5500-$6500. New York, N. Y. Y-1608.

MAINTENANCE ENGINEER, 30-35, mechanical graduate, with considerable mill-maintenance experience, preferably along textile lines, to supervise maintenance, modernization, and some construction. $5000-$5400. Eastern Pennsylvania. Y-1637.

DESIGNERS, mechanical engineers, 5 years' experience in power process, plant layout, and piping. Starting salary $5200. Location Philadelphia. Low-cost hospital and insurance plans. Homes available. Transportation paid. R-5264(b).

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Nov. 25, 1948, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

AULD, WILLIAM M., Bound Brook, N. J.
AVERY, RALPH L., Buffalo, N. Y.
BASSETT, JOHN L. D., New York, N. Y.
BECK, JOSEPH H., New York, N. Y.
BEDELL, KENNETH H., Chicago, Ill.
BIERLEIN, CARL A., Cleveland, Ohio
BOOTZ, ERNEST J., New York, N. Y.
BOWCOCK, R., Cornwall, Ont., Can.
BOWDEN, WALLACE THOMAS, Barberton, Ohio

(*ASME News continued on page 954*)

BRYANT, ROUTT A., JR., Los Angeles, Calif.
CASHIN, F. J., E. Williston, N. Y.
CRANE, E. V., Brooklyn, N. Y.
CROSSETT, J. W., New York, N. Y.
CRUMP, LAWRENCE R., Los Angeles, Calif.
CURTIS, CHARLES ROBERT, Philadelphia, Pa.
CURTIS, MYRON SHIRLEY, Shaker Heights, Ohio
DAVIS, HOWARD C., Columbus, Ohio
DINAN, JOHN J., Baltimore, Md.
DIXON, JOSEPH O., Fairlawn, N. J.
DODSON, CHARLES W., Harrisburg, Pa.
DRIVER, W. S., Los Angeles, Calif.
ELLMAN, FRED, Cincinnati, Ohio
ELSTON, CHAS. W., Schenectady, N. Y.
ESSER, HAROLD H., Chicago, Ill.
FELL, ARTHUR D., Philadelphia, Pa.
FRASER, WALTER G., JR., Prospect Park, Pa.
GILLIS, ROBERT M., Chicago, Ill.
GOLDEN, V. C., Lafayette, Ind.
GRADY, ROBERT E., San Francisco, Calif.
HAGNAUER, W. W., Waukegan, Ill. (Rt & T)
HALL, THOMAS E., N. Long Beach, Calif.
HALLIDAY, BERNARD A., Denver, Colo. (Rt & T)
HANSEN, OLUF B. H., New York, N. Y.
HARRELL, W. L., Houston, Texas
HARRISON, E. D., Blacksburg, Va.
HARSHMAN, J. B., Tulsa, Okla.
HASSELL, THOMAS W., Dallas, Texas
HERMAN, E. S., Alhambra, Calif.
HIGSON, KENNETH J., Middletown, Conn.
HOWELLS, WILLIAM H., Cleveland, Ohio
HUCKER, C. R., Los Angeles, Calif.
JAFFE, GERALD, New York, N. Y.
JENSEN, LEO CHRISTIAN, Spokane, Wash.
JOHNSON, R. H. J., Weston, Ont., Can.
JONES, G. S., W. Los Angeles, Calif. (Rt)
JOSHI, M. G., Stoneclough, Lancashire, England
KALET, MILTON, New York, N. Y.
KEITH, JOHN WILBUR, Galveston, Texas
KING, LYMAN S., San Francisco, Calif.
LAITALA, EVERETT, Champaign, Ill.
LANE, EMIL, Los Angeles, Calif.
LAUER, HERBERT H., Glens Falls, N. Y. (Rt)
LE VELLE, JAMES A., Dallas, Texas
LEGETT, JOHN L., New Orleans, La.
LIPPMANN, ARTHUR W., Wauwatosa, Wis. (Rt & T)
LOFTUS, JOHN T., Dorchester, Mass.
LONG, FRED A., Huntington Park, Calif. (Rt & T)
LOOS, ALFRED H., Lima, Ohio
MAC LEOD, JOHN A., Boston, Mass.
MANCHESTER, WARREN L., Los Angeles, Calif. (Rt & T)
MASUR, ERNEST F., Chicago, Ill.
MCALLISTER, LEW A., Lafayette, Ind.
MCBRIDE, FRANCIS WENDELL, Inglewood, Calif.
MECUSKER, M. R., Los Angeles, Calif.
MILMOE, ROBERT, Los Angeles, Calif.
MITCHELL, PHILIP B., Memphis, Tenn.
MOORE, PAUL B., Youngstown, Ohio
MOORE, RICHARD P., Los Angeles, Calif.
MORROW, HAROLD WM., JR., Vermillion, S. D.
NELSON, EDWIN L., Rahway, N. J.
NOREM, BERT HOLLAND, Syracuse, N. Y. (Rt & T)
OSBORN, JACK STOELTING, Tulsa, Okla.
PARKER, J. S., Trona, Calif. (Rt & T)
PETRY, STANTON H., Evanston, Ill.
PIKE, ALBERT L., Portland, Ore.
PLAISTED, THOMAS, Auburn, Me.
POLINEK, CHARLES J., Cleveland, Ohio
POPLIS, ALEXANDER C., Ednor, Md.
POWELL, EDWIN DEAN, Spencer, N. C. (Rt)
PRESGRAVE, R., Toronto, Ont., Can.
PRIVE, PIERRE ALEXANDRE, Montalivet, Paris, France
RECCHIONE, DOMINIC, Jackson Heights, N. Y.
REDDING, PASCHAL E., JR., Macon, Ga.
REED, C. LAWSON, JR., Cincinnati, Ohio
RICHARDSON, EDWARD W., Dover, Del.
ROBERTS, O. R. H., Wilmington, Calif.
SAWYER, LUCIAN AUSTIN, Atlanta, Ga.
SCHAFRANIK, ERICH, Providence, R. I.
SCHARF, ARTHUR, Columbus, Ohio
SCHMITT, ROBERT D., Philadelphia, Pa.
SCOTT, GEORGE E., Minneapolis, Minn.
SHARP, ROBERT A., Wauwatosa, Wis.
SHERWIN, EDWIN T., Chicago, Ill.
SHIELDS, CARL D., Wilmington, Del.
SIDWAY, CHARLES L., Los Angeles, Calif.
SIGLOW, THADDEUS A., New Castle, Pa.
SKALANGYA, JOHN, Runnemede, N. J.
SKINNER EDWARD T., Stillwater Okla.
SPEICHER, WILLIAM, North East, Pa.
STAINS, W. A., Burbank, Calif.
STECHERT, FRED. E., Los Angeles, Calif.
STEVENS, BROOKS, Milwaukee, Wis.
STEWART, JAMES E., Moline, Ill.
TAVANLAR, E. J., Quezon City, Philippine Islands (Rt & T)
TIFFIN, WILLIAM T., Gainesville, Fla. (Rt&T)
TOMBACH, H., La Follette, Tenn.
VON SCHUTZ, WERNER, Fellbach, Stuttgart, Germany (Rt)
WALKER, RICHARD L., Los Angeles, Calif.
WARD, EDWIN GRANT, Crawfordsville, Ind.
WESTON, CARL A., Charlotte, N. C.
WHITE, ROBERT L., Charlotte, N. C.
WILBER, ALBERT B., Oswego, N. Y. (Rt & T)
WILCOX, A. L., Chicago, Ill.
WILLIAMS, BENJAMIN R., St. Louis, Mo.
WITTE, E. F., Joliet, Ill.
YOUSOUFIAN, RICHARD M., Bedford, N. H.

Transfer to Member

BAILEY, EUGENE C., La Grange, Ill.
BARBIERI, JOHN D., Brooklyn, N. Y.
BELL, JOHN A., Pittsburgh, Pa.
BOWAR, EARL C., Minneapolis, Minn.
COCHRAN, D., Schenectady, N. Y.
COLLINS, A. R., Indianapolis, Ind.
COYKENDALL, W. E., JR., Riverside, Conn.
DE LANEY, JAMES CECIL, JR., Houston, Texas
DIEFENDORF, DONALD W., Cazenovia, N. Y.
DOWNS, JACK EDWIN, Swampscott, Mass.
DRUM, LEO J., JR., Montgomery, Ala.
ERMENC, JOSEPH J., Hanover, N. H.
FISHER, HAROLD S., New Brunswick, N. J.
GALVANEK, EDWARD J., Port Reading, N. J.
GRACIK, JOHN W., Long Island City, N. Y.
GUINS, SERGEI G., Olmsted Falls, Ohio
GUTE, HARRY, Milwaukee, Wis.
HAGLUND, G. O., Buffalo, N. Y.
HENDERSON, R. W., Albuquerque, N. Mex.
HJERPE, CARL W., Baltimore, Md.
HOLCOMBE, MARSHALL M., New York, N. Y.
HUTCHISON, GIBSON T., Philadelphia, Pa.
JANICEK, JOSEPH J., Chicago, Ill.
JENNINGS, FREDERICK A., Birmingham, Mich.
JOHNSTON, ELMER M., Richland, Wash.
KOCH, CHARLES H., Philadelphia, Pa.
KREAMER, WILLIAM H., Roanoke, Va.
LAMPL, JOSEF, Los Angeles, Calif.
LAMSON, OTIS F., JR., Seattle, Wash.
LANG, FREDERIC ALLISON, Wilmington, Del.
LEMBCKE, ROBERT K., Indianapolis, Ind.
LENTZ, LAWRENCE W., Algonac, Mich.
LEVINE, A., Jersey City, N. J.
LOHR, JAMES A., Indianapolis, Ind.
MC ARTHUR, RALPH F., Huntington Park, Calif.
MCLAIN, WILLIAM R., Henderson, Ky.
MONTGOMERY, BRYANT S., Knoxville, Tenn.
NEILSON, GEORGE E., St. Louis, Mo.
ONUF, BRONIS R., New Haven, Conn.
OZIMEK, STANLEY J., Maplewood, N. J.
PIEPENBRINK, ROBERT E., Chicago, Ill.
POWELL, E. M., New York, N. Y.
PRENTISS, JOHN H., New York, N. Y.
PRICE, C. G., JR., Harrisonburg, Va.
RECKNAGEL, PAUL W., Springfield, Ohio
REICHERT, GEORGE L., Chicago, Ill.
ROBERTSON, JAMES M., State College, Pa.
ROSSETTO, LOUIS, Brooklyn, N. Y.
SCHWARTZ, WILLIAM J., Port Austin, Mich.
SWANSON, MAURICE C., Schenectady, N. Y.
THOMAS, E. FLOYD, Nashville, Tenn.
TSU, T. C., State College, Pa.
WEST, WOODROW W., Rosemont, Pa.
WILLIAMS, R. E., JR., Birmingham, Ala.
WITT, TED R., Kingsport, Tenn.
YOUNGQUIST, ROBERTSON, Baltimore, Md.
ZOWSKI, THADDEUS, Evanston, Ill.

Transfers from Student Member to Junior......300

Starting Engineering Salaries Waver

COMPARISON of average starting engineering salaries by the Illinois Institute of Technology show a leveling off and may mean that the peak in demand for graduate engineers by industry is not far off.

Figures released by J. J. Schommer, director of placement at Illinois Tech, indicate that the starting salary of the June, 1948, class was 53 cents less than the February, 1948, class.

Chemical-engineering graduates dropped $20, civils $9, and electricals $6. The mechanical-engineering graduates gained by $3, the industrials $5, and the fire-protection and safety graduates $20.

The June average was $264.72 or more than two and a half times greater than the starting salary 10 years ago. In 1938 the graduating engineer averaged $100 per month.

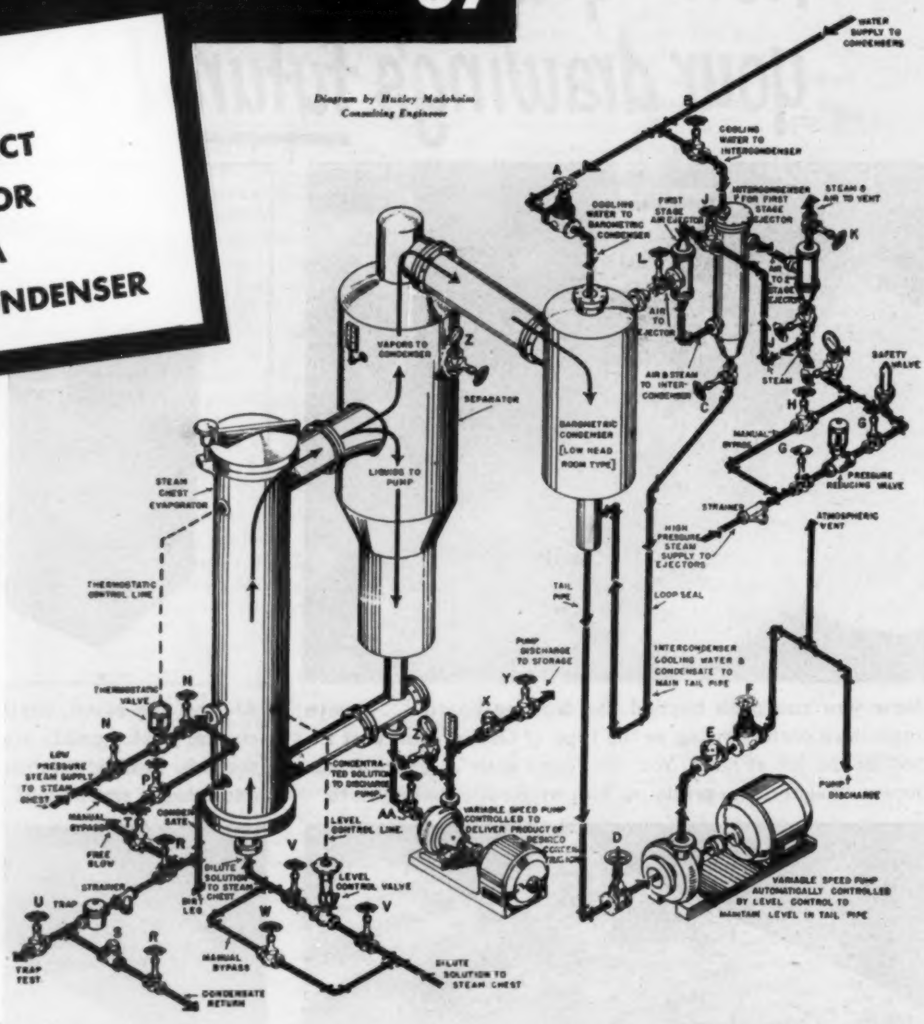
Necrology

THE deaths of the following members have recently been reported to headquarters:

CARLSON, AXEL F., March 14, 1948
FOX, FRANK W., August 5, 1948
HAAR, SELBY, September 5, 1948
HIGGINS, ALDUS CHAPIN, September 10, 1948
HOLTER, ALFRED, July 17, 1948
KETCHAM, CHRISTIAN B., July 6, 1948
LITTLER, CARL W., date not known
MACPHERSON, JOHN GUMESON, July 21, 1948
MARQUIT, CARL HAESSLER, August 1, 1948
MYERS, ROBERT DUANE, August 28, 1948
PUMPHREY, KEITH FRANKLIN, June 21, 1948
REUNERT, THEODORE, date not known
SEAMAN, JOSEPH, August 20, 1948
SLOAT, BENJAMIN CROSBY, July 21, 1948
STILLMAN, THOMAS BLISS, September 28, 1948
UPDIKE, DAVID M., July 24, 1948
WHITING, EDWARD M., date not known

Jenkins PRACTICAL PIPING LAYOUTS 37

How to plan a SINGLE EFFECT EVAPORATOR USING A BAROMETRIC CONDENSER



A typical single effect evaporator, or vacuum pan, used extensively in the food industries for concentrating dilute solutions—such as juice, soluble coffees, boullions and soups—is shown in this layout.

Because high temperatures would destroy the product, excess water must be boiled off at low temperatures under a vacuum, generally produced by a barometric condenser with a tail pipe. The tail pipe pump drive is automatically controlled to maintain a constant liquid level in the tail pipe.

The evaporator may be operated continuously, as shown, or as a batch process arrangement. To avoid corrosion and contamination, all valves in contact with the product being treated must be of selected metals, such as stainless steel or bronze, depending on local codes.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation. Copies of Layout No. 37, enlarged, with additional information, will be sent on request. Just mail coupon.

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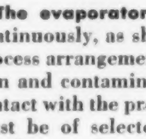
VALVE RECOMMENDATIONS
For details and valves to suit varying conditions see Jenkins Catalog

Code	Quan.	Jenkins Valve	Service
A	1	Fig. 142—IBBM Globe	Control Cooling Water to Barometric Condenser
B	1	Fig. 106A—Bronze Globe	Control Cooling Water to Intercondenser
C	1	Fig. 47—Bronze Gate	Shutoff Intercondenser Discharge
D	1	Fig. 651—IBBM Gate	Shutoff Tail Pipe Pump Suction
E	1	Fig. 624—IBBM Sw. Check	Prevent Backflow to Tail Pipe Pump
F	1	Fig. 142—IBBM Globe	Tail Pipe Pump Discharge
G	2	Fig. 49—Bronze Gate	Pressure Reducing Valve Shutoff
H	1	Fig. 956—Bronze Globe	Manual Bypass of Press. Red. Valve
J	2	Fig. 976—Bronze Globe	Steam Supply Control to Ejectors
K	1	Fig. 49—Bronze Gate	Shutoff 2nd Stage Ejector Discharge
L	1	Fig. 47—Bronze Gate	Air Takeoff from Barometric Condenser
M	1	Fig. 741G—Bronze Needle	Pressure Gage Control
N	2	Fig. 47—Bronze Gate	Thermostatic Valve Shutoff

Code	Quan.	Jenkins Valve	Service
P	1	Fig. 976—Bronze Globe	Manual Bypass of Thermostatic Valve
R	2	Fig. 47—Bronze Gate	Steam Trap Shutoff
S	1	Fig. 92—Bronze Sw. Check	Prevent Condensate Backflow
T	1	Fig. 106A—Bronze Gate	Free Blow of Condensate
U	1	Fig. 106A—Bronze Gate	Trap Test
V	2	Fig. 47—Bronze Gate	Level Control Valve Shutoff
W	1	Fig. 106A—Bronze Globe	Manual Bypass
X	1	Fig. 92—Bronze Sw. Check	Pump Discharge
Y	1	Fig. 106A—Bronze Globe	Control Pump Discharge
Z	2	Fig. 741G—Bronze Needle	Pressure Gage Control
AA	1	Fig. 47—Bronze Gate	Pump Suction

ALTERNATE STAINLESS STEEL VALVES

Code	Quan.	Jenkins Valve	Service
V	2	Fig. 1300—Stainless Steel Gate	Level Control Valve Shutoff
W	1	Fig. 1308—Stainless Steel Globe	Manual Bypass
X	1	Fig. 1328—Stainless Steel Check	Pump Discharge
Y	1	Fig. 1308—Stainless Steel Globe	Control Pump Discharge
Z	2	Fig. 1308—Stainless Steel Globe	Pressure Gage Control
AA	1	Fig. 1300—Stainless Steel Gate	Pump Suction



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BUYER'S CATALOG GUIDE

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FOR convenience in locating catalogs about a particular piece of equipment, product or service, a list is given below in which the numbers refer to the catalog items beginning on page 44. This will aid you in locating something specific although a perusal of the entire list may disclose something of more than usual interest or something that you may have been looking for.

THIS November 1948 insertion of BUYER'S CATALOG GUIDE replaces the regular "Keep Informed" Section for this issue. The "Keep Informed" Section will appear regularly again beginning with the next issue.

As previously, MECHANICAL ENGINEERING carries a list of brief items concerning up-to-date trade literature issued by advertisers in A.S.M.E. Publications and restricted to them.

Make a selection and indicate on the coupon on page 43 by circling the numbers of the literature described and fill in the balance of the coupon completely, for no literature will be sent if firm connection and position are not given. Enclose coupon in envelope and mail to—

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Continued on Page 43

CATALOG ITEMS Start on Page 44 and Run to Page 62 Inclusive

How to Build Stronger, Lighter Levers at Less Cost

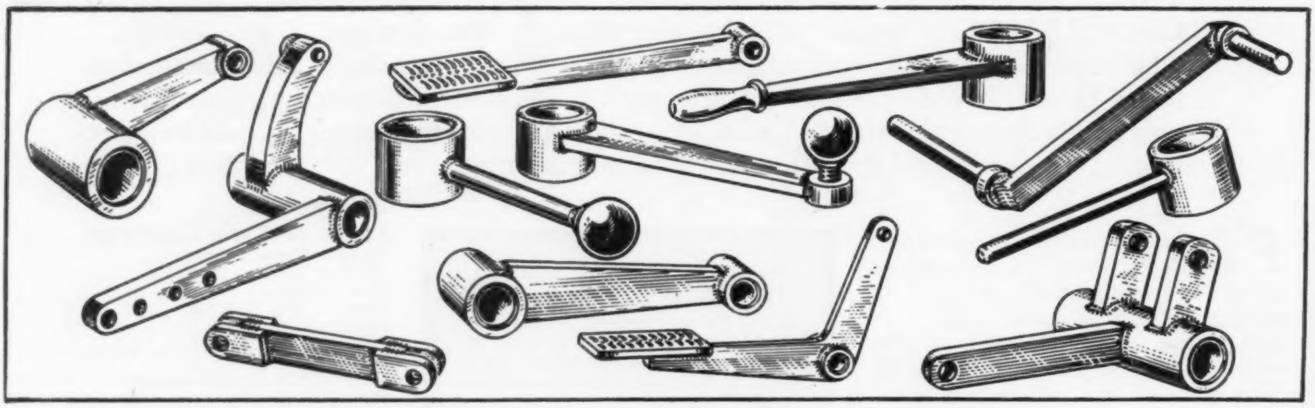

Fig. 1. Typical machinery operating levers that are being weld-fabricated at lower cost with arc welding.

ALL types of levers are being weld-fabricated in shops throughout the country, helping to produce stronger, lighter machinery construction with improved appearance . . . *all at less cost than with other methods.* Here is how these levers are built:

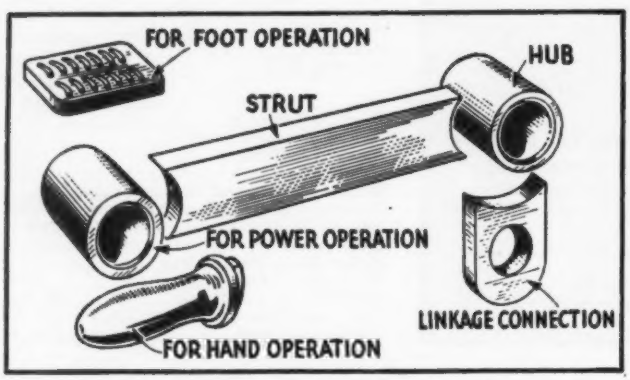

Fig. 2. Basic elements of levers for different types of operation.

More detailed data on the design of levers for arc welding is contained in the "Procedure Handbook of Arc Welding Design and Practice." Price $1.50 postpaid in the U. S. A.; elsewhere $2.00.

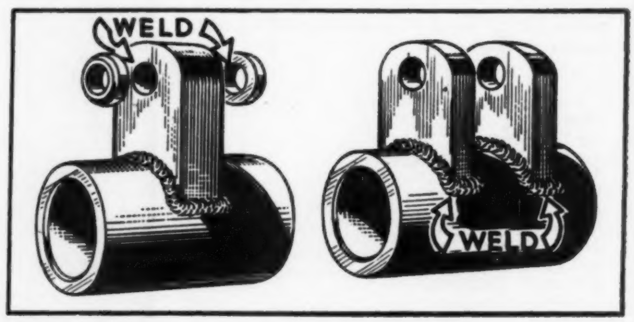

Fig. 3. Linkage connections for power take-off, made from steel straps.

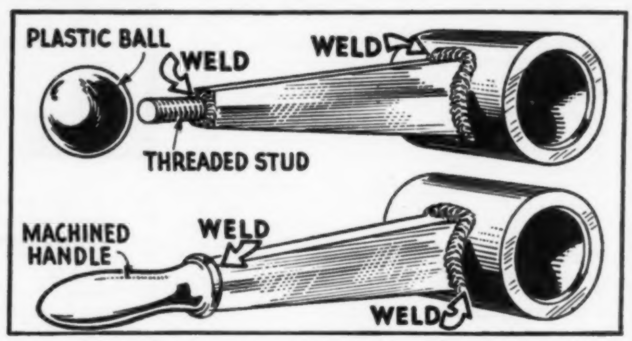

Fig. 4. Handles weld-assembled for manual operation.

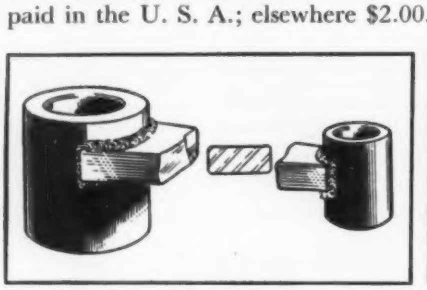

Fig. 5. Plain rectangular strut welded to hubs. For normal loads.

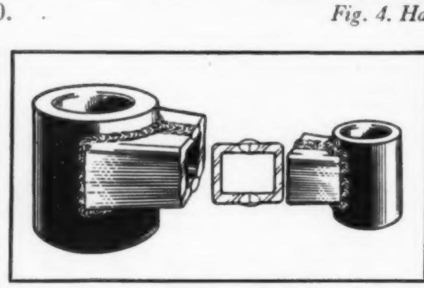

Fig. 6. "Box" section design strut for strong, light-weight construction.

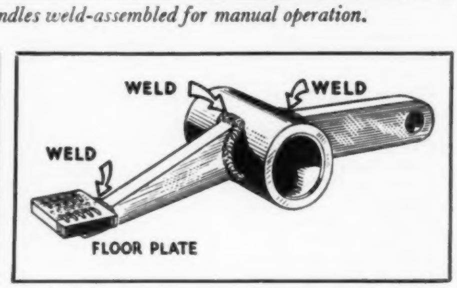

Fig. 7. Floor plate weld-attached for foot operation.

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1 STROBOSCOPIC EQUIPMENT

General Radio Co.—"Eyes for Industry" a 24-page Booklet discussing stroboscopic instruments and techniques for using them. In addition to the measurement of speed, a number of applications are illustrated showing the use of stroboscopes in solving engineering, design, and production problems.

2 PYROMETERS

Leeds & Northrup Co.—Micromax and all other L&N plant instruments for measuring, recording and controlling temperatures detected by thermocouples are described in Catalog N-33A. Temperature instruments for use with Rayotubes are described in Catalog N-33B. For information on high-speed Speedomax Recorders for industrial temperatures, see Catalog ND46. Complete equipment for checking thermocouple pyrometers is listed in Catalog E-33A-503.

3 V-BELT DRIVES

Medart Co.—Bulletin VE-48. A complete new bulletin on the engineering of V-belt drives, containing the new Medart type SL V-belt sheave. Complete engineering tables and drive section tables in condensed and easy to interpret arrangement.

4 MINIATURE BALL BEARINGS

New Hampshire Ball Bearings, Inc.—Technical Bulletin No. 48 gives specifications of four types of "Micro" Ball Bearings, two of them previously only available in large sizes, with dimensional data and tolerances, fits, load speed and life. Included are stainless steel and non-magnetic bearings.

5 MACHINING COPPER AND COPPER BASE ALLOYS

American Brass Co.—30 pages of practical suggestions in Anaconda Publication B-3. Covers tools, speeds and feeds, rakes and clearances, machineability ratings, applicable specifications, etc.

6 BRONZE CASTING ALLOYS

American Manganese Bronze Co.—50-page Edition of the "Reference Book on Bronze Casting Alloys," recently published. In it is given general information regarding composition, characteristics and applications of many of the common or typical alloys. The book will help the engineer or designer in the selection of the right alloys for any general application.

7 PERMANENT MAGNETS

Indiana Steel Products Co.—Permanent Magnet Manual No. 4 is a 32-page booklet covering a short history of magnets and their four fundamental classifications in application. It discusses current theory and materials, basic types and air gaps, and demagnetization and energy product curves. Several sections are devoted to design engineering, processing and handling. A glossary of magnetic terms and symbols is also included.

8 METAL ABRASIVES

Globe Steel Abrasive Co.—Bulletin describing "Malleabrasive," a new and revolutionary type of Metal Abrasive for use in airless blasting equipment for blast-cleaning gray iron, Malleable, steel and brass castings. Available in form of round shot and angular grit. Recommended to reduce over-all blast cleaning costs as much as 50%.

9 VALVE PACKING

Edward Valves, Inc.—Catalog 12-R, complete valve packing information. Features EValpak, a durable, heat resisting, molded packing produced specifically for Edward cast and forged steel valves in high temperature and high pressure services. Includes installation information, illustrations, detailed description, and complete tables showing list prices per set for all current Edward designs. Water-proofed and highly resistant to most organic solvents, EValpak is built to correct proportions for Edward steel valves.

10 COOLING TOWERS AND SPRAY NOZZLES

Marley Co.—Bulletin G-48. A reference bulletin, describing every kind of water cooling tower and spray nozzle manufactured by them including: the new re-designed Aquatower, a small-capacity tower available in seven sizes for specified refrigeration loads; atmospheric towers for medium and light service; and the Double-Flow tower for large installations. This bulletin gives an overall view of water cooling equipment and refers the reader to more detailed bulletins on specific products.

11 PUMPS

Aurora Pump Co.—Condensed Catalog M, embodying illustrations, suggested uses, specifications, and condensed selection tables for Aurora Centrifugal and Apco Turbine-Type Pumps and Water Systems. Inquirers may obtain further information on any types shown by writing for special bulletins containing additional information. Also see their A.S.M.E. Mechanical Catalog, page 56.

12 STOCK SPROCKETS

Diamond Chain Co., Inc.—Catalog No. 598 contains 28 pages on standard Machine Steel, and Cast Iron Sprockets for single, double or triple strand chains. A method of calculating length of chain required, a Motor Drive Table, and a Chart showing speed ratios for sprocket combinations are also included. In addition, Diamond Flexible Couplings are illustrated and described with handy reference data.

13 THERMOSTATIC STEAM TRAPS

Sarco Co.—A stainless steel element for pressures to 300 psi and for corrosive condensate is a feature of the new line of Sarco thermostatic steam traps. Condensate and air venting capacities of all traps are practically doubled, thru a new design which permits traps to reach rated capacities with a drop from steam temperature of only 10° F. New Bulletin 250-A.

14 GASKETS AND WASHERS

Phoenix Specialty Mfg. Co.—Catalog describing plain corrugated metal, solid metal, corrugated metal-asbestos, single jacket asbestos, double-jacket asbestos, doubled armored asbestos, corrugated jacket asbestos, French Style, composition and special shaped gaskets. Also washers, shims and pump valves. Designed to meet severe demands as required by power plants, processing plants, aviation companies, elevator manufacturers, instrument makers, U.S. Army and Navy.

15 PRECISION TYPE GEARS

Fairfield Manufacturing Co.—16-page Brochure abundantly illustrates the continuous program of metallurgical laboratory research, the scientific gear generating and testing procedures, and accurate gear cutting and grinding, heat treating, checking and testing operations which are embodied in every Fairfield gear. Shows the wide variety of made-to-order fine gears produced for use in production tools, industrial and agricultural machinery and construction equipment.

16 COMPRESSOR VALVES

J. H. H. Voss Co.—Voss Valves are applicable to any make and type of air, ammonia, or gas compressor; are supplied to manufacturers of new machines, as well as to users, for replacing inefficient, unsatisfactory or worn out valves. Designed skillfully for each individual job, made on special machinery from alloy or stainless steel, they are unsurpassed in efficiency, reliability, and safety. Literature explains how and why Voss Valves offer great improvement over obsolete valves or cheap cast iron plate or ribbon valves.

17 STOKERS

Hoffman Combustion Engineering Co.—Latest Brochure, File 201-208, describes spreader stokers with either forward or rear discharge moving grate structures. Includes pictures of machine parts and line drawings. Also line drawings and engineer's descriptive details on spreader stokers with dumping grates. Also special features with pictures and complete details.

18 MECHANICAL SHAFT SEALS, PACKINGS AND "O" RINGS

Crane Packing Co.—Bulletin describes design and application of "John Crane" Bellows Shaft Seals. Illustrated with cutaway views, typical installations and dimensional standards, application data, installation procedure and practice. Complete catalog of Metallic, Fabric on Plastic Packings will also be furnished.

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19 WELDING RODS

American Manganese Steel Div., American Brake Shoe Co.—Bulletin 1047-W, 28 pages on how to keep equipment of all types operating and producing through Amsco conservation welding. Contains photographs, drawings and descriptions explaining the low cost method of keeping hard-to-get parts out of the scrap pile by repairing and hardsurfacing with Amsco welding rods and electrodes.

20 LIGHT DUTY CONVEYOR DRIVE UNIT

Island Equipment Corp.—New 4-page illustrated Bulletin No. 12-3-48-11A—"Pakaged" Power Unit. Contains illustrations, brief outline and technical data on a new self-contained Light Duty Belt Conveyor Power Unit furnished with 1/4, 1/3 or 1/2 h.p. motors, either with fixed speed or variable speed drives. Made to take belts from 6" width up to 36" width.

21 STEAM GENERATORS

Superior Combustion Industries, Inc.—Features of Superior Steam Generators are colorfully presented in Catalog No. 110 with complete data and dimensions describing 17 sizes ranging from 20 to 500 b.h.p., for 15 to 250 lbs. pressure. Specifications show equipment for burning gas or oil, or both. Catalog No. 210 describes smaller units of 5 to 40 b.h.p.

22 SLIDE RULES

Frederick Post Co.—Post Hemmi Slide Rules—unquestioned accuracy at all times, constructed from carefully selected and laminated bamboo which resists contraction and expansion under varying climatic conditions, white celluloid faces used for easy reading with deep-cut graduations engine-divided to insure a lifetime of accurate calculation.

23 INDUSTRIAL INSTRUMENTATION

Foxboro Co.—Catalog 370 presents the company's full line of recording and indicating instruments for measurement and control of industrial processes. Arranged for quick reference, and profusely illustrated, the sections deal with instruments for temperature applications, pressure, flow, humidity, liquid level, density, and other variables. The Dynalog all-electronic instruments are shown. A section is devoted to special instruments. Control valves, planimeters, instrument accessories and supplies are also listed. Branch office addresses are given.

24 INCLINED DRAFT GAGES

Uehling Instrument Co.—Bulletin 1146 describes the Uehling Type B Inclined Draft Gage for accurately measuring drafts, pressure, or differential pressure, ranges up to 8" water, 40" scales, graduated for every 1/100" of waterhead.

25 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross-section drawings of typical units for both moderate and high steam pressure conditions; a description of the Terry axial flow impulse, both singlestage and multistage. Terry gears are used for speed increasing and speed reducing.

26 LUBRICATORS FOR CAR JOURNALS

Miller Felpax Corp.—The Felpax felt wick lubricator replaces old-fashioned skein yarn packing for locomotive traction motor suspension bearings. Greatly increases bearing life and reduces maintenance. Also available for overhead cranes, etc.

27 TUBING

Bundy Tubing Co.—New 20-page Booklet in colors. Contains technical data and fabricating information on Bundyweld steel (copper or tin coated) tubing of particular interest to production and design engineers in metal-working industries.

28 FANS

Propellair Div. of Robbins & Myers, Inc.—Condensed Catalog No. 3032 containing performance data, dimensions and application photographs of latest Propellair direct drive fans is now available on request. Ranging from 1000 CFM to 85,000 CFM this handy compilation of data shows the adaptability of airfoil propeller fans to most industrial ventilating problems in the lower pressure range.

29 WATER TUBE BOILERS

Springfield Boiler Co.—New illustrated technical Bulletin describes 2-drum bent tube steam generators, sectional header straight tube boilers, and standardized Type M boilers produced by this company. Bulletin also presents reports on boiler

Continued on Page 46

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installations, power cost reducing programs, and describes Springfield design and construction features.

30 METAL FORGING

Steel Improvement & Forge Co.—A new 44-page Reference Data Booklet contains technical information on types of forgings, design forging principles, dies and tools required for forging, characteristics and applications of forging metal, forging production processes, heat treating procedure, machining of forgings and inspection procedure. Describes the relationship of a forging plant to your organization.

31 OIL BURNERS

Ray Oil Burner Co.—Catalog of horizontal rotary burners for heavy oil, 1 to 1000 BHP, fully automatic, semi-automatic or manual; belt or direct drive; combination gas-oil burners; pressure atomizing gun type for light oil; industrial gas burners; water heaters, ranges, pumpsets, and domestic winter air conditioners from 105,000 to 450,000 Btu.

32 DIRECT-LINE PRINTING PROCESS

Charles Bruning Co.—"BW Direct-Line Printing Process" is a title of a Booklet containing BW Print samples. The book presents samples of the various types of BW Prints that can be produced on all Bruning BW Printing and Developing Machines with text explaining their many uses and advantages.

33 PIPE AND TUBE BENDING AND FABRICATING

Pipe & Tubular Products, Inc.—Complete information and data regarding pipe and tube bending and fabricating is available upon request. Items produced include the bent type boiler tubes—generating, superheating, waterwall tubes, etc.; pipe and tube coils, tubular shapes for structural purposes, in all metals. For any purpose requiring bent pipe or tubing either for passage of gas or liquids or structural purposes, inquiries are solicited.

34 ELECTRIC MOTORS

Fairbanks, Morse & Co.—An entirely new type of electric motor designated as "Axial Air-Gap" is described in a new Bulletin No. 2760. This new motor is the most radical departure in design since the introduction of electric motors. Its principles are revolutionary. The magnetic lines of force follow a path parallel to the shaft (or axis of rotation) as compared to a radial path taken by the magnetic flux in the conventional type of motor. Sizes from 1/3 to 10 HP. Outstanding features are space and weight reduction, the Axial Air-Gap motor being less than half the size and weighing 30% less.

35 OXYGEN RECORDERS

Hays Corp.—Bulletin 48-829, entitled, "Electronic Type Recording Instruments for Oxygen, Carbon Dioxide, Temperature and Pressure." 16-page bulletin on the interesting developments made by Hays in the electronic instruments and controllers. Complete description of the new Hays Magno-Therm Oxygen Analyzer and Acratron Electronic Type Recorder, the latter used in connection with other types of electronic analyzers, such as the Thermo-Conductivity type, for CO_2 and other gases.

36 FLOAT VALVES

Klipfel Manufacturing Co.—Float Valves—Single seated and double seated, angle and globe patterns—for automatic control of liquid levels in open or closed tanks, are fully described and illustrated in Bulletin No. 346CM. Construction and operation details as well as dimension and weight tables are included.

37 ROLLING DOORS AND GRILLES, FIRE DOORS AND SHUTTERS

Kinnear Mfg. Co.—A 28-page Catalog describing the complete line of Kinnear rolling doors, rolling grilles, fire doors and shutters, bi-folding doors, wood rolling partitions and door operating equipment and accessories. The catalog is attractively printed and illustrated with numerous photographs and drawings of door installations. Complete specifications, construction details and methods of installing the various types of doors are provided or explained.

38 FLUID POWER VARIABLE DELIVERY FEED PUMPS

Oilgear Co.—New 8-page Bulletin 44200 illustrating and describing their New Fluid Power Variable Delivery Feed Pump that is simple, compact, electro-hydraulically controlled; easy to apply nearby or remotely, and quick and positive in action; a development of importance to all machine tool builders, processing equipment manufacturers and users. It's automatic pressure compensated. Fine and coarse feeds are adjustable over a 20:1 range. It provides from 13:1 to 265:1 variable ratios between feeding and rapid traverse speeds. Only two pipe lines are required. It's safe, easy to service. It's 25% lower in unit cost.

39 1-TON MULTIPRESS MIDGET

Denison Engineering Co.—Bulletin M-15-A, describes in full the new Multipress Midget, 1-ton capacity hydraulic press announced recently. Available for manual or automatic control—only $325.00 less motor and starter. Press and pumping unit are mounted in compact packaged form, easily set up on standard work bench or fitted into assembly line operations. The bulletin is profusely illustrated and complete installation information included.

40 ROTARY COMPRESSORS AND VACUUM PUMPS

Fuller Co.—16-page Bulletin C-5, Fuller Rotary Compressors and Vacuum Pumps. Cross-section drawings of machines, photos of important parts of machine, with many installation photos. Also tables giving sizes, capacities, motor sizes, overall dimensions, etc. Built for capacities to 3300 c.f.m., 125-lb. pressure-vacuums to 29.90-in. (referred to 30-in. barometer).

41 BLOWERS, EXHAUSTERS, PUMPS, ETC.

Roots-Connersville Blower Corp.—Regularly issues individual Bulletins covering Centrifugal Blowers and Exhausters; Rotary Positive Blowers, Gas Pumps, Liquid and Vacuum Pumps; Positive Displacement Meters, and Inert Gas Generators. Bound bulletin sets are available on request in lieu of complete catalog, which permits changes as new bulletins are published from time to time.

42 LEATHER BELT DRIVES

J. E. Rhoads & Sons—Handbook containing engineering data for the design and installation of Rhoads Tannate—Rockwood Drives—a combination of Tannate Flat Leather Belt, Pivoted Rockwood Base and Suitable Pulleys. Contains a graphical method for computing the correct overhang of the motor required to transmit a given load under all conditions of operation. It also contains a method for figuring belt widths and bearing pressures. Enables any engineer or draftsman to compute the motor overhang accurately.

43 STEAM GENERATORS

Foster Wheeler Corp.—Bulletin PG 48-4 is a 4-page, 2-color bulletin describing Foster Wheeler package steam generators. Sectional drawings of basic designs, and tables giving capacities and dimensions of units, are included. Outstanding features relating to efficiency, superheat, controls, installation and operation are also discussed briefly.

44 INSULATED CONDUCTOR SYSTEMS

Benbow Mfg. Co.—New 8-page Bulletin describing fully insulated Trac Troly systems with illustrations of use in cranes, hoist, monorail, and portable tool installation. Catalog and price information are enclosed in bulletin.

45 VIBRATION CONTROL

M B Mfg. Co.—Bulletin No. 405 gives advantages and installation data on vibration-isolating Pads designed for use under flat-base or footed machines and equipment. Booklet 4-5 provides helpful design data on mountings. Also Technical Paper on "Simplified Method for Design of Vibration Isolating Supports" and the Isomode Design Chart.

46 PROCESS STEAM TRAPS

Warren Webster & Co.—Bulletin B-1200G, 32-page Catalog and data book on application of traps for venting and condensate drainage in process steam installations to 150 lbs/sq.in.; sterilizing, pasteurizing, steam cooking, laundry, textile drying and food dehydrating.

47 FLOW METERS

Fischer & Porter Co.—Recommendations on construction materials for almost 400 corrosive liquids and gases are tabulated in 4-page Bulletin. Literature was designed specifically for selecting materials for use in "Flowrator" flow measuring equipment. Data is also valuable for use in selecting materials for other uses than in flow meters.

48 COAL AND ASH HANDLING EQUIPMENT

Fairfield Engineering Co.—Catalog 144 gives complete description of equipment engineered to profitably handle coal and ash under all conditions. 121 pages of illustrations, detail drawings and tables. Large section showing basic types of installations for advance planning. Also sections on glass batch and other materials handling equipment. Serviceable, leather-bound cover.

49 SELF-LOCKING NUTS

Elastic Stop Nut Corp. of America—Revised product Data Sheets describe the complete ESNA line of

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self-locking nuts. Individual data sheets show hex, clinch, spline, instrument mounting, high tensile and anchor types of vibration proof nuts, specially designed to meet industrial-fastening problems. Thread sizes, availability of stock, hex dimensions and weights are listed.

50 LUBRICATION

Lubriplate Div., Fiske Brothers Refining Co.—Has released for distribution to plant managers, superintendents, maintenance engineers and others having to do with lubrication a very unique Slide Data Chart. The use of this chart permits of the quick determination of the correct lubricant for application to diversified mechanical equipment, also data concerning characteristics of lubricant selected.

51 INDUCTION HEATERS

Electric Arc, Inc.—Recently revised Catalog Sheet now includes complete descriptions and illustrations on induction heating equipment for preheating and stress relieving when welding. Also shown and described are control instruments which have been specifically designed for use with the various models of induction heaters.

52 MULTITHERM UNITS

Clarage Fan Co.—Bulletin No. 107, Clarage Multitherm Unit for vital industrial air conditioning services. Types to furnish cooling only, heating only, or year-round control of temperature and humidity, quickly installed—no building alterations or elaborate duct system required. Used to speed production. Large range of sizes.

53 SYNTHETIC RUBBERS

B. F. Goodrich Chemical Co.—Illustrated Booklet on Hycar American Rubbers, acrylonitrile butadiene and butadiene styrene type, giving answers to questions concerning the manufacture, properties, and uses of Hycar, with accompanying charts, tables and photographs. To manufacturers of oil resistant and oil soluble products, this booklet is indispensable.

54 FLUID ENERGY REDUCTION MILL

C. H. Wheeler Mfg. Co.—A Pamphlet which describes the operation and functions of the Fluid Energy Reduction Mill. This mill reduces materials to low and sub-micron sizes at high efficiency. Classification of particle size is accomplished within the mill. Functions of dehydrating, coating, chemical reactions and blending and mixing can be combined with grinding in this mill.

55 SPEED REDUCERS

W. A. Jones Foundry & Machine Co.—Catalog No. 70, 126 pages of the latest information on Jones Herringbone Speed Reducers. Horsepower ratings and service factors are shown in accordance with the recommended practice of the American Gear Manufacturers' Association. Examples for selecting reducers for various service conditions are given. The book is illustrated with a section featuring the widespread use of Herringbone Reducers for varying service conditions.

56 SMALL STEAM BOILERS

Union Iron Works—A new Catalog No. 120 describes Union's Little Giant, a self-contained boiler-furnace unit in 10 standard sizes, 15 to 80 horsepower. Welded one piece pressure element supported independently of steel cased refractory furnace lining. Furnace extends full length of boiler, is made up of 9" firebrick backed by 2" of block insulation. The boiler is shipped as a complete unit and complete dimension data is included in the catalog.

57 FRACTIONAL HORSEPOWER GEARS

Gear Specialties—4-page Catalog Bulletin illustrating and describing many different types and applications of G.S. Small Gears. Illustrating many applications entirely without precedent; new principles, new design, new engineering. Gears from 12 to 96 D.P.

58 MATERIALS HANDLING

Syntron Co.—100-page Catalog illustrating and describing "Syntron" Electric Vibrators for bins, hoppers and chutes, vibratory feeders, feeder machines, bowl feeders, spiral elevator feeders, paper joggers—and a line of power tools including self-contained gasoline hammer paving breakers, portable electric hammers, drills, grinders, sanders and concrete vibrators.

59 HYDRAULIC POWER UNITS

Vickers, Inc.—Bulletins 46-26a, 46-43a and 47-45 contain detailed descriptions of the advantages offered by Vickers Hydraulic Power Units. Available in a wide range of standard sizes with a variety of pumping and valving equipment, or custom built

Continued on Page 48

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to suit specialized requirements. Bulletins also show typical circuits, specifications, and capacities for both general and specific installations.

60 ADJUSTABLE TYPE REVOLVING JOINTS

Barco Mfg. Co.—Catalog No. 295 illustrates and describes this new Barco industrial product—The Barco adjustable Type Revolving Joint—for use on all types of rolls, drums and driers for air and Hydraulic brakes and clutches. Capable of operating up to 750 r.p.m., at approximately 1000# hydraulic oil pressure. As part of the same unit, a Barco Adjustable Ball Flange has been developed which is used to correct eccentric tapping or roll misalignment, eliminating the weave of the piping.

61 POLARISCOPES

Polarizing Instrument Co.—To the machine designer, photoelastic stress analysis is not only of value in the verification of calculations based on theoretical solutions, but also in the solution of problems where theoretical analysis is not available. Be up to date. Descriptive Literature of their photoelastic equipment.

62 STEAM AND LIQUID CONTROLS

O. C. Keckley Co.—Catalog 49, Steam and Liquid Control Equipment, containing 48 pages. Valves, precision pressure regulating, relief and float; temperature regulators; self-cleaning strainers; water gages; gage cocks; illuminators; steam traps and air separators are described. Includes dimensions, application, capacity, list price and engineering tables and specifications.

63 BALL BEARING PILLOW BLOCKS

Fafnir Bearing Co.—Information about light series pillow blocks, flange cartridges and cylindrical cartridges equipped with sealed wide inner ring ball bearings is contained in a new 8-page Booklet designated as "Lak" Folder. The units described are widely used for carrying light or normal loads in applications where simplicity of installation is an important factor. Photographs, sectional drawings, specifications and load ratings are included.

64 VIBRATION CONTROL—MOUNTINGS, FLEXIBLE COUPLINGS, BONDED RUBBER

Lord Manufacturing Co.—Bulletin 900 describes the complete line of Lord Vibration Control Mountings, Flexible Couplings and Bonded Rubber-to-Metal products. Bulletin illustrates products for vibration isolation and shock control. Technical letters available on vibration control. Test reports, installation data and assembly drawings available concerning Aircraft Engine Suspensions.

65 AUTOMATIC CONTROLS

General Controls Co.—New Catalog No. 52E covering the complete line of automatic temperature, pressure, level and flow controls is a handy reference for engineers. Illustrations, engineering data and specifications fully describe this broad line of automatic controls to assist the engineer in selecting the best control for the job.

66 IRON CEMENTS

Smooth-On Mfg. Co.—40-page, pocket size Smooth-On Repair Handbook describes practical, time-saving, money-saving metal repairs made on plant, shop, factory, garage and home equipment with Smooth-On Iron Cements. Leaks stopped, cracks sealed, loose parts and fixures tightened. More than a million copies of this popular Manual have already been sent out in response to requests. Contains 170 diagrams. Clear tested directions.

67 GRATING—FLOORING, SAFETY THREADS, ETC.

Irving Subway Grating Co.—Catalog No. F-225 contains illustrations, descriptions and engineering data on fireproof, durable, safe, clean and economical Gratings and Safety Steps (riveted, pressure-locked and welded) for Industrial Plants, Power Plants, Refineries, Ships, Railroad Freight and Passenger Cars and Locomotives, Open Steel-Mesh Bridge Decking, etc.

68 GEAR INFORMATION

Illinois Gear & Machine Co.—Catalog No. 39 contains useful tables and directions for ordering, and presents gears for every purpose; bevel, internal, mitre, spiral, spur and worm; also pinions and sprockets, produced under a shop-wide quality control program.

69 AUTOMATIC PALLET LOADERS

Lamson Corp.—Are exclusive sales representatives for the newly developed Automatic Pallet Loader built by the Production Aids, Inc., Van Nuys, California. Complete service specifications, dimensions, suggested applications, are given in a 4-page Bulletin.

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70 STEAM TURBINES

Murray Iron Works Co.—Bulletin T-122 illustrating and describing Murray Type UV steam turbines. Type UV turbines are designed for modern steam pressures and temperatures. UV turbines may be provided with features and accessories for any type of drive.

71 WATER TUBE BOILERS

Babcock & Wilcox Co.—Complete details of the design, application, and operating advantages of the B&W Integral-Furnace Boiler Type FH, are contained in a new 24-page Bulletin. For moderate to large capacity and industrial and public utility usage, the boiler embodies an improved design evolved from the experiences of more than 1500 users of the original unit since 1933. All features are fully discussed and illustrated, and many actual installation drawings, embracing a wide variety of applications, fuels, and types of firing, should particularly interest plant engineers.

72 FLEXIBLE COUPLINGS

American Flexible Coupling Co.—New 24-page three-color Booklet "Relief From Bearing Wear Grief" has been published describing the functions of flexible couplings and their effect upon bearings, shafts, motors and equipment. A thorough explanation is given to the principles by which couplings operate, and their importance in relationship to the equipment it connects. The operation and maintenance of the American Flexible Coupling is fully described.

73 WATER TUBE BOILERS

Henry Vogt Machine Co.—New 20-page Bulletin describing the Class LE, 4-drum bent tube boiler. Photo and line drawings with design data, illustrates typical units as installed in various industries.

74 BALL BEARINGS

New Departure, Div. of General Motors—Supplementing its standard Catalog, a series of five books, helpful to the engineer and designer in applying ball bearings to any new machine. The first book deals with principal bearing types and fundamentals of mounting practice; the second, details of shaft and housing designs; and the third, enclosure and lubrication for varying operating conditions; the fourth book gives a new simplified method of computing bearing loads, while the fifth entitled, "Application Procedure," outlines the necessary steps in obtaining assured bearing performance.

75 AIR AND GAS COMPRESSORS

Pennsylvania Pump & Compressor Co.—Bulletin 201 describes Company's line of horizontal, single stage, double-acting air and gas compressors. These compressors are available in sizes from 15 to 125 HP, for pressures up to 125 psi gauge. Bulletin includes detailed description of important features.

76 ANALYTICAL INSTRUMENTS

Consolidated Engineering Corp.—General Catalog—CEC 1300A. Presenting, in brief form, the complete lines of precision instruments designed and manufactured by them. The first section of this catalog is devoted to Consolidated Mass Spectrometers, including the new isotope-Ratio Mass Spectrometer; Vacuum Leak Detectors and Electrical Computers. Static-Dynamic Measuring and Recording Systems are thoroughly covered in the second section along with Recording Oscillograph, Galvanometers, Accelerometers and Velocity Pickups, and Calibrators.

77 PUMPLESS, MOTORLESS HYDRAULIC POWER PRESSES

Elmes Engineering Works of American Steel Foundries—Bulletin No. 1036 explains the simple operating principle, gives complete specifications to 50-ton capacity, illustrates bench and floor models of low-cost Elmes Hydrolairs that take their power entirely from the regular shop air line. Also other bulletins covering other types of presses and other types of hydraulic production equipment.

78 ROLLER DRIVE CHAINS

Jeffrey Mfg. Co.—Recently published new Catalog No. 808, which contains 60 pages of pertinent information on steel thimble roller drive chains. The text, on page 2, points out that Jeffrey was the originator of this type of chain so universally used in industry today. In the reproduction of the chain itself, on pages 10 to 23, the exact pitch of the chain has been adhered to in every case. Many interior views of our Chain-making department and the application views make this book worthwhile.

79 HONING

Micromatic Hone Corp.—12-page Folder, form AR 98 contains 34 illustrations. The folder is catalog

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BUYER'S CATALOG GUIDE . . . LATEST INDUSTRIAL LITERATURE

type publication showing new machines, tools, fixtures and abrasives. Condensed machine specifications are given along with a brief discussion of honing and honing applications. Other literature available on specific phases of honing on request.

80 DRAWING PENCILS

A. W. Faber-Castell Pencil Co.—Descriptive detail tells of the scientific preparation of "Castell" Drawing Pencils, especially the graphite lead made according to a secret A. W. Faber process several generations old.

81 TECHNICAL BOOKS

John Wiley & Sons—Publishers of scientific and technical books. 1948 Catalog available, contains descriptions of more than 1350 books in engineering, science, technology and education. Of particular interest to mechanical engineers are the following recently published Wiley titles: "Heat Pumps," by Sporn, Ambrose and Baumeister; "Centrifugal and Axial Flow Pumps," by A. J. Stepanoff; "Panel Heating and Cooling Analysis," by Raber and Hutchinson; "Principles of Jet Propulsion and Gas Turbines," by M. J. Zucrow; and "Gas Tables," by J. H. Keenan and J. Kaye.

82 PAPER-MATED ERASERS

Eberhard Faber Pencil Co.—Cleaner corrections, neater erasures, are now possible as a result of a scientific study that shows how to match paper... work...and eraser. Illustrated Folder "Paper-Mated Erasers" will save you time, money and patience.

83 ELECTROFLUID DRIVE

Link-Belt Co.—16-page, illustrated Data Book No. 2085-A on new Electrofluid Drive, a compact power unit, combining electric motor and fluid coupling for industrial uses. Eliminates both shear pins and "overmotoring." Protects driven machinery and material in process from damage by shock or overloading. Assures smooth pickup without excessive starting current.

84 OIL FILTERS FOR INTERNAL COMBUSTION ENGINES

Wm. W. Nugent & Co.—Bulletin 7B illustrates and describes Nugent filters for fuel and lubricating oils for internal combustion engines. Diagrams for filter connections to engine lube system illustrates full flow and partial filtering. Filter sizes from 1/4 to 400 GPM. Filters contain cloth bags or absorbent cellulose elements; both may be used with additive type oils.

85 CATHODE-RAY TUBES AND INSTRUMENTS

Allen B. DuMont Labs., Inc., Cathode-Ray Instrument Div.—Practical information regarding the tools of present-day oscillography—tubes, oscillographs, allied equipment and accessories—is now available in the new Catalog just issued. This literature which is a "must" in the working library of any one engaged in oscillographic work, features a wide selection of standard items.

86 SMOKE DENSITY RECORDERS

Bailey Meter Co.—4-page Bulletin explains operation of Bolometer type smoke density recorder. Drawings and photographs illustrate the construction and application of the electronic type smoke recorder, the sealed beam light source, and the sealed beam Bolometer type smoke detector which make up the complete unit for the measurement and recording of smoke densities in ducts and stacks. The Bolometer is described as a modified, sealed beam automoile head lamp which receives all radiation from the light source which is passed by the smoke column. Circuit diagram illustrates method of compensating for voltage variations and ambient temperature changes.

87 ROLLER BEARINGS

McGill Mfg. Co., Bearing Div.—New Bulletin No. SE-47 describing the S.E. series of Multirol bear-

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ings. Applications and specifications included on this full type roller bearing series.

88 RIVET SPINNING SIMPLIFIED

Grant Mfg. & Machine Co.—Literature is now available on an Automatic Trip Mechanism for use on Grant Noiseless Rivet Spinning Machines. The literature shows what size machines the Trip may be used on and explains how the Trip eliminates worker fatigue and insures the proper formation of consistent rivet heads.

89 SQUARE TYPE HEATING BOILERS

Kewanee Boiler Corp.—Catalog 88-4 in its third printing shows Square Type "R" Boilers for heating medium size buildings. This series of eight boilers is now available either jacketed or unjacketed for loads 900 to 3000 sq. ft. steam radiation in upper bracket of S.B.I. residential code.

90 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—New 35-page Hyatt Handbook "Guide Lines for Engineers and Designers." A guide to the proper application of cylindrical roller bearings in machinery and equipment of all types. With design drawings of successful, tested applications, it illustrates the fundamental needs which must be provided for in the machine designed: namely—retainment, shaft location, housing, lubrication seals and closures.

91 CHRONOMETRIC HAND TACHOMETERS

Boulin Instrument Corp.—8-page Bulletin describing and illustrating portable Tachometers designed to measure constant rotary and surface speeds. Provides data on instruments widely used in industry for accurate measurement and precise indication of three distinct ranges of speeds including ultra low, medium and high.

92 AIR PREHEATERS

Air Preheater Corp.—The first section of their Catalog on Ljungstrom Air Preheaters presents an over-all picture of the Ljungstrom, its functions and operation. Examples of installations of the Ljungstrom continuous counterflow regenerative type preheater, covering a range of diverse applications, are shown in diagrammatic form, together with photographs of the Ljungstrom in sufficient detail to make its principle and operation clear.

93 DIE-LESS DUPLICATING

O'Neil-Irwin Mfg. Co.—The "Di-Acro" Line of Precision Machines has been greatly expanded and today six different types of machines are available in a total of eighteen different sizes as offered in the latest edition of "Die-Less Duplicating" Catalog No. 48-13. "Di-Acro" Benders, Brakes, Shears, Notchers, Punches and Rod Parters can be efficiently employed either individually or cooperatively for duplicating a wide range of precision parts or complete products. They are also extremely valuable in model shops and experimental laboratories for fabricating the many parts which are required from day to day.

94 FUEL OIL PUMPING AND HEATING UNITS

National Airoil Burner Co.—Fuel Oil Pumping and Heating Units for preparing for combustion heavy fuel oil for all types of burners. Bulletin No. 40, 16 pages, illustrates single and twin units, steam and motor driven, also tables of capacities, suction line sizes, discharge line sizes, etc.

95 OIL AND GAS BURNERS

Anthony Co.—General Bulletin illustrates and briefly describes all Anthony "Nebulyte" Burners for oil and gas, either alone or in combination. These burners are adaptable to all types of industrial heat application as well as boilers. Bulletin also lists allied products including duplex strainers, controls, forges, furnaces, heavy duty torches. See their page 48, ASME Mechanical Catalog for 1949.

96 VERTICAL TURBINE PUMPS

Layne & Bowler, Inc.—Bulletin 4-42 featuring vertical turbine pumps, capacity range from 40 to 16,000 GPM, suitable for direct connected electric motor drive, engine drive through right angle gear or quarter turn flat or vee belt. Any pumping head or length of column.

97 FABRICATING SEAMLESS ALLOY TUBES

Babcock & Wilcox Tube Co.—A new edition of Technical Bulletin 9 describes methods of working seamless tubes and pipe of the intermediate B&W Croloys of the ferritic—air hardening type containing 1/2% to 9% chromium. This revised bulletin, issued in convenient pocket size, supplies up-to-date practical information or instructions for proper handling of these alloy tubing steels to obtain maxi-

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mum benefit from their use. Photographs, diagrams, tables, and charts provide ready reference data for the shop man performing fabricating operations on these materials.

98 DRAFTING ROOM FURNITURE

Hamilton Mfg. Co.—Hamilton Drafting, Furniture . . . streamlined . . . described in the New Hamilton Catalog No. 13-S . . . Auto-Shift tables with instant adjustment for height and slant from horizontal to vertical . . . tracing files with patented tracing lifter, making every sheet a top sheet . . . and a complete line of files and drawing tables to meet all requirements.

99 PRESSURE GAGES

Helicoid Gage Div., American Chain & Cable Co.—Just released, new 16-page Helicoid Gage Catalog. The Helicoid Gage is the only pressure gage with the Helicoid Movement. It is guaranteed accurate to within 1/2 of 1% of the total dial graduation over the upper 95% of the 280° dial arc. This means that on a 100 lb. dial for example, accuracy is guaranteed to within 1/2 lb. over the entire scale except from 0 to 5 lbs. A newly designed adjusting mechanism, located in the rear of the gage, makes possible recalibration without removing the pointer and the dial. This is a feature industry has long been looking for. Cutaway photographs and line drawings show the complete line of Helicoid Gages, how they work, what goes into them, how they're put together, and the reason why they're so accurate.

100 PRESSURE AND OIL STORAGE TANKS

Novelty Steam Boiler Works Co.—Our new 20-page Bulletin gives latest information on ASME and commercial design pressure tanks and Underwriters' Labelled Oil Storage Tanks. Filled with all essential data that is pertinent to tanks and tank supplies including capacities and recoveries of submerged copper heating elements. Amply illustrated.

101 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—New 4-page Bulletin, illustrated, gives specifications on more than 40 different types and sizes of standard miniature ball bearings. Also shows special bearings and gives interesting product information.

102 STEAM HUMIDIFIERS

Armstrong Machine Works—12-page Bulletin, Form 1771, deals with the need for humidification, particularly during the heating season. Operation of electrically-controlled and air-actuated units fully explained. Bulletin contains capacity information, as well as data on humidifier selection, spacing and installation.

103 DIRECTORY OF PRODUCTS

Allis-Chalmers Mfg. Co.—This 32-page Directory—25B6057—lists the more than 1600 Allis-Chalmers products made for power generation, power distribution and power utilization together with engineering literature available on a wide range of equipment for the farm, mine, industry and utility.

104 HYDRAULIC CYLINDERS

Hannifin Corp.—Bulletin No. 110, 52 pages, contains complete descriptions, specifications, dimensions and other data on the Hannifin standard line of hydraulic cylinders: 12 standard bore diameters from 1" to 8", 11 standard mounting styles and a variety of combination styles; standard, double end, and heavy duty (2 : 1) piston rods; with or without adjustable cushions; pressures to 1500 p.s.i.

105 MARKING AND NUMBERING MACHINES

Acromark Co.—New Catalog illustrating and describing hundreds of marking and numbering machines, marking and numbering tools and their applications with general specifications. Catalog also includes illustrations and general information upon name and number plates, industrial plant signs of metal, porcelain enameled iron and plastic, as well as inks for marking and printing metals, plastics and other materials.

106 STEAM BOILERS

Wickes Boiler Co.—Bulletins No. 44-1-2-3-4 and 46-1-2 describing water tube boilers of the 2-, 3-, and 4-drum design for direct firing by means of oil, pulverized coal, or stokers; also waste heat units, Dowtherm, and package-type water tube boilers. Boilers are built for pressures up to 850 p.s.i. and capacities to 250,000 lbs. of steam per hour.

107 PUMPS

Pacific Pumps, Inc.—Bulletin 101, 4 pages describing two-stage, vertical split case process pumps for capacities to 600 G.P.M., pressures to 600 p.s.i. and temperatures to 850°F.—Bulletin 102, 4 pages, describing horizontal split case, double suction volute pumps for speeds to 4,000 R.P.M., capacities to 3,000 G.P.M., pressures to 450 p.s.i. and temperatures to 500°F.—Bulletin 103, 4 pages, describing horizontal split case, muti-stage pumps for speeds to 4500 R.P.M., capacities to 2350 G.P.M., pressures to 1200 p.s.i.

108 GEARED SPEED REDUCERS AND INCREASERS

Lufkin Foundry & Machine Co.—New 48-page Gear Catalog G-1 covers complete line of Horizontal Parallel Shaft Herringbone Gear Reducers and Increasers. Complete Engineering Data covers method of making selection of proper type and size. Single and Double Reduction Gears for standard speeds; and high quality, precision assembly for High Speed Reducing and Speed Increasing Service.

109 PUMPS

DeLaval Steam Turbine Co.—DeLaval-Imo Pumps—Series C31C—Catalog C31C illustrated with cutaway views showing internal parts. This catalog describes the IMO pump as used for handling viscous fluids or for handling fluids at unusually high suction lifts, or under high vacuum such as encountered in pumping from deaerators and vacuum evaporators. Includes construction details and table of outline dimensions.

110 VALVES, FITTINGS, PIPE

Walworth Co.—Catalog 47, streamlined, 500 pages crammed full of helpful information to users of valves, fittings, and pipe wrenches. Materials, dimensions, pressures, temperatures, and other engineering data are given in clearly indexed sections. The Engineering Data Section includes many original Charts and Tables helpful in figuring the sizes and types of piping necessary for particular operating conditions.

111 STEEL HEATING BOILERS

Farrar & Trefts, Inc.—Boilers of welded steel construction are built in accordance with A.S.M.E. Code as well as State and Insurance Inspection Requirements. Standard sizes range from capacities of 1,800 to 42,500 square feet of steam radiation. Complete specifications in Bison Steel Heating Catalog No. 4A.

112 SUCTION PUMPS

Economy Pumps, Inc.—Horizontal, single stage, double suction pumps for general water supply and booster service; brine or hot water circulation; condenser injection; hot well or makeup water service white water and overflow in paper mills are described in new Bulletin No. A-1147Cm. Construction details and selection tables are included.

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113 PHOTOGRAPHIC PAPERS FOR ENGINEERING

Industrial Photographic Div., Eastman Kodak Co.—A new line of Kodagraph Papers for reproducing engineering drawings and for office photocopying is described in a new Booklet "The Big New Plus." The line includes Kodagraph Contact Paper, Kodagraph Projection Paper, Kodagraph Fast Projection Paper, and Kodagraph Autopositive Paper; a revolutionary new photographic paper which can be handled in ordinary room light and which produces a positive copy directly from a positive original. This is valuable as a printing intermediate—particularly in making legible shop prints from worn, discolored, or opaque originals. Information is given regarding the use of these materials with conventional drafting room equipment.

114 STEAM BOILERS

Heilman Boiler Works, Inc.—Recent development introducing multi-drum vertical water tube steam generator. Choice of firing materials from anthracite or bituminous coal, oil, sawdust, or refuse fuel. Sizes available are 3,000 pounds steam and up coal fired, and 4,500 pounds steam and up oil fired. Latest regulating equipment. Pressure 150 pounds up.

115 STEEL AND ALLOY PLATE FABRICATION

John Nooter Boiler Works Co.—New 16-page Folder indicating descriptive applications in stainless steel, copper, nickel, aluminum and various alloys; together with comprehensive corrosion data charts, indicating the use of each of these materials; fabrication of processing equipment built around the use of shielded arc, atomic-hydrogen, oxyacetylene and automatic submerged head types of welding.

116 SOLENOID VALVES

Ruggles-Klingemann Mfg. Co.—Complete revised Catalog "E" on Electrically Operated Valves. This not only includes valves previously listed with revisions but several new designs such as a small and compact 3- and4-way solenoid pilot, External pilot and Emergency Trip 3-way valves and others. Complete description for each type.

117 WATER SOFTENERS

Permutit Co.—Bulletin 2997 describes the application of the Sludge Blanket Design to hot process method of softening water, and explains the advantages. (1) Delivers soft water. (2) 50% more silica removed than with previous types of equipment. (3) Eases load on filters. (4) Substantial savings in chemicals.

118 EXPANSION JOINTS AND FLEXIBLE CONNECTORS

Zallea Brothers—Catalog 47 contains 60 pages of data, illustrations and descriptive matter on all types and uses of expansion joints and flexible connectors. A combined catalog and textbook on expansion joints, Catalog 47 is indexed and arranged to facilitate selection of the proper types for the proper applications.

119 ENCLOSED WORM GEAR DRIVES

Foote Bros. Gear & Machine Corp.—Bulletin HPA fully describes Foote Bros. new "Hypower" enclosed worm gear drives and contains complete ratings and dimensions. These units are smaller in size than conventional drives of equal capacity, lower in original cost and lower in operating cost. Available in horizontal and vertical types with ratios complying with the speed-ratio standards adopted by AGMA-NEMA.

120 FLEXIBLE METAL HOSE

Atlantic Metal Hose Co.—Recently issued new Catalog No. 100, which illustrates and describes Flexible Metallic Hose of Seamless Construction made in various metals such as Bronze, Carbon Steel, Stainless Steel, Monel, etc., and which is made to resist the highest engineering pressures. Suitable for handling compressed air, gases, liquids, chemicals, etc. Furnished in commercial sizes and lengths to specifications.

121 BEARING BRONZE

Bearium Metals Corp.—Three-color, 6-page Folder describes the frictional properties available in Bearium Metal and illustrates typical bar stock sizes and individual castings. Photomicrographs show structure and lead distribution achieved in production of this metal, accounting for its advantages for bearings, bushings, thrust washers and other requirements involving rubbing friction.

122 LIQUOR PUMPS

Warren Steam Pump Co.—New Bulletin 245 recently released fully illustrates and describes their

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line of Types "L," "LS," and "A" Liquor Pumps for process industries. These centrifugal pumps have a wide range of applications, which include pumping of hot or cold erosive or corrosive liquids. Sectional views in the bulletin clearly illustrate the mechanical features and the text covers technical details.

123 FLEXIBLE COUPLINGS

Lovejoy Flexible Coupling Co.—Illustrated Catalog with Selector Charts. Grouping and application of L-R Flexible Couplings. Describes and pictures various types of couplings, with cutaway views and diagrams. New couplings for D-C standard mill motors. Selector Charts make it easy to choose correct type and size of coupling with proper cushion material for application.

124 BALL BEARINGS

Nice Ball Bearing Co.—Latest Catalog, No. 125, describes and illustrates complete line of ball bearings ranging from exacting close tolerance precision units to inexpensive pressed steel bearings of the unground type. Listings cover radial, thrust and combined radial-thrust bearing types, and other Nice anti-friction products, such as ball bearing sheaves, rollers, wheels and casters. Listings include capacity ratings and complete list price and discount information.

125 O-RING SYNTHETIC PACKINGS

Linear, Inc.—Handy and convenient 8-page Folder lists standard sizes of "Linear O-Ring" packings and gaskets. Contains complete dimensional data for installation, general design notes and illustrations of typical application of O-Ring packings as static and movable seals. Description of packings is limited to physical dimensions and general installation and design data in the folder itself. However, a separate sheet will be included which will describe a number of "Linear" compounds, each designed for specific operating conditions.

126 POWER PRESSES

V & O Press Co.—"S" Line Bulletin No. 48 which gives engineering data concerning their "S" Line of Power Presses. This is the latest line they have developed.

127 AIR CYLINDERS

Cushman Chuck Co.—Bulletins describing their Aluminum Body Air Cylinders that operate successfully up to 5000 R.P.M. speeds. An improvement has been introduced in jaw adjustment for power operated chucks which permits micrometer adjustment of work holding jaws to precision centering.

128 TUBULAR HEAT EXCHANGERS

Griscom-Russell Co.—A particularly detailed Bulletin on tubular coolers, heaters, condensers and heat exchangers. Describes and illustrates the many available designs of stationary heads, floating heads, tube bundles and shells, and also the most advanced design details that assure satisfactory service. Includes several useful tables and charts.

129 VARIABLE SPEED CONTROL

Reeves Pulley Co.—114-page General Catalog, G-450A, shows how variable speed control can be applied to all types of production machines to step up output production, decrease production cost and improve processing. Most comprehensive book on variable speed ever published. Many specific examples, illustrations, recently revised dimension tables and engineering tables. Complete details on latest improvements and additions to Reeves Lines. Catalog includes all the various sizes of variable speed equipment with the latest mechanical electrical and fully automatic controls available.

130 PRESSURE REGULATORS

Davis Regulator Co.—Bulletin No. 100A describes the standard Davis line of pressure regulators and reducing valves for steam, air, gas, water, oil and other fluids. Complete data on 18 standard types in sizes up to 24" and for pressures to 1500 p.s.i.

131 PISTON RINGS

C. Lee Cook Mfg. Co.—New 36-page Catalog No. 470 fully describing the complete line of Cook Graphitic Iron Piston Rings for industrial size Diesels, Steam Engines and Compressors. The catalog gives details on ring design and construction, ring service and ring specifications. Included are engineering tables, diagrams and data as well as practical suggestions relative to the ordering of piston rings.

132 SYNTHE-SEAL BEARINGS

Marlin-Rockwell Corp.—Bulletin containing complete information on M-R-C Synthe-Seal Bearings—a standard dimension Ball Bearing with a removable synthetic rubber seal impervious to oils and greases.

133 AE PERFECT SPREAD STOKERS

American Engineering Co.—Compact, automatic, coal-firing unit, capacities 175 H.P. to 200,000 lbs. of steam per hour and upwards. Noteworthy for non-clogging feeder handles solid fuels of any moisture content with wide ranges from lignite to highest grades, sizes $1^1/_2$ inch to screenings. Available with stationary, dumping or continuous ash discharge grates. Catalogs Nos. S-492-A-5M-746-90 and S-491-A-3M-347-96.

134 NON-FERROUS AND STAINLESS STEEL FASTENINGS

H. M. Harper Co.—New 32-page Stock Catalog of non-ferrous and stainless steel fastenings, gives the most comprehensive listing of standard fastenings available from stock today. Covers a wide range of forms, sizes, materials, and is sectionalized for convenient, instant reference into the main divisions of Bolts, Nuts, Screws, Washers, Rivets, Accessories. Also included are complete dimensions, packaging data and prices on more than 5000 individual items in Harper Chicago and New York warehouses.

135 "HYDRO-FINISH" BLAST CLEANING

Pangborn Corp.—Holding tolerances to .0001 inch, "Hydro-Finish" is a modified form of impact blasting using a fine abrasive suspended in a liquid. The process has unlimited applications in the Tool Room, in the Production Line and in the Cleaning Department. It improves surface finish, removes oxide scale and increases tool and die life. Send for new Bulletin 1400.

136 STRAINERS

J. A. Zurn Mfg. Co.—Basic principles of strainers, used for quality control purposes and to protect various pipeline equipment, is fully described in this new strainer Catalog. Technical information contained includes tables and analysis of pressure drop,

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open area ratios, screen sizes, rate of flow, metals, temperature and pressure resistances of various strainers manufactured including duplex, sinlex, "Y" and angle types.

137 VENTILATING EQUIPMENT

Chelsea Fan & Blower Co.—Illustrated Brochures containing information and engineering data regarding fans and blowers for ventilating and cooling, for exhausting fumes, steam, excessive heat and paint spray. For use in factories, foundries, chemical plants, breweries, laundries, cold storage plants, etc.

138 SPREADER STOKERS

Flynn & Emrich Co.—New Catalog—No. 1301, giving complete details together with illustrations, cross section views, and features of the new "F & E" Spreader Stoker with electro-hydraulic drive, incremental control valve, and alternate coal feed pusher. This catalog is designed to supply the information needed by the Architect or Engineer.

139 METAL FLOATS

Chicago Float Works, Inc.—20-page Catalog describing floats for liquid level and other types of float actuated mechanism, including seamless copper, unplated copper floats, stainless steel, aluminum steel, monel metal, and brass floats, together with useful information on standard and special shapes and a wide variety of float connections, tables giving volume, displacement, and net buoyancy, together with formulae and information useful to designers in the application of floats.

140 AIR OR HYDRAULICALLY OPERATED CYLINDERS

Engineering Products Co.—Bulletin 453 gives description, list of applications, dimensions, weights, capacities of a line of heavy duty cylinders operated by air, oil or water at pressures up to 1000 lbs. per sq. in. Sizes available are 2", 3", 4", 6" and 8" diameter with stroke lengths 6", 12", 18", 24" and 36". Bulletin shows various attachments for heads and rods to give universal mounting possibilities.

141 GAS CYLINDERS

Scaife Co.—A new LP-gas cylinder, called the "Lightweight Champion," is described and illustrated in a 4-page Bulletin No. 500. Outstanding feature of the new "Lightweight Champion" is the Info-Crown which carries all cylinder data stamped clearly and deeply, and also adds strength and rigidity to the cylinder head. Tare weight, cylinder number, and other needed data are stamped in large letters on the Info-Crown and are arranged so that they can be easily read when the cylinder is standing on the ground or floor. Also features a continuous-support stand ring which provides uniform support around the entire periphery of the cylinder. The ring insures that the load is evenly distributed and localized pressure points eliminated. A new cylinder head profile developed by Scaife equalizes head stress, assuring maximum strength at minimum weight.

142 SCRUBBERS AND COOLERS

Peabody Engineering Corp.—New three-color Bulletin, No. H-203, on Gas Scrubbers and Coolers. Complete with diagrammatic sections, illustrations explaining both the multi-stage and single-stage scrubber and cooler, the new Peabody bulletin also carries diagrams of the Peabody impingement baffle-plate action and actual performance.

143 CENTRIFUGAL PUMPS

Lawrence Machine & Pump Corp.—Bulletin No. 210 on its new Self-Priming Centrifugal Pump. Also an enlarged edition of Bulletin No. 203-4, on acid and chemical pumps.

144 NIBCOLOY PIPE FITTINGS

Northern Indiana Brass Co.—Nibcoloy Wrot Fittings—Catalog 902—12 pages. Features, specifications and price tables of Lock-Ring and Butt-Weld Fittings and New Lock Flange Fittings which are available in Inconel, Nickel, Monel and Stainless Steel, size ranges 1/4" O.D. to 4" O.D. for application in chemical, petroleum, process, food and other industries where corrosion, turbulence, contamination and abrasive action are encountered.

145 POWER TOOLS

Mall Tool Co.—A line of portable power tools is described in a 20-page catalog, Bulletin No. 746 which consists largely of photographs of the various power tools which comprise the Mall line. Accompanying each photograph is text which lists the tools' specifications and describes the job it is intended to do. The text also covers the various accessories designed to increase the usefulness of Mall tools. Items listed in the catalog include the MallSaws, the MallSaw stand, MallDrills, attach-

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ments for use with the drills, MallSanders, portable polishers, flexible shaft grinding and sanding machines, carpenters' planes, and others.

146 JACKETED VALVES

Reed Valve Div. of Reed Roller Bit Co.—Bulletins covering the line of Jacketed Steel and Jacketed Cast Iron Valves. Designed for handling materials which are either very viscous or which tend to harden or congeal at ordinary temperatures. Can be furnished with any interior or exterior surfaces protected with baked plastic coatings when service temperatures do not exceed 350° F.

147 FLEXIBLE METAL HOSE AND TUBING

American Metal Hose Branch of The American Brass Co.—12-page Catalog CC-165 illustrates and describes basic types of strip-wound metal hose and seamless flexible metal tubing. Shows types of fittings available, lists physical properties and bending diameters.

148 CONVEYORS AND MATERIALS HANDLING EQUIPMENT

Mechanical Handling Systems, Inc.—Illustrated Bulletins including engineering data covering materials handling problems. Bulletin M-3, "Monoveyors," contains complete information on overhead trolley conveyors. F-5, Floor Type Conveyors. L-1, "Eleveyors," portable and adjustable inclined belt conveyors. TV-1, "TwinVeyors," flexible and portable conveyor for bagged goods. RV-1, "RopeVeyor," flexible and portable conveyor for bags, cartons, cases, packages, etc. R-2, "Universal Work Carriers," tiering racks for transportation and storage of miscellaneous products. C-1, "Collapsi-Bin," combination heavy duty bin, rack, and pallet in one unit.

149 GRINDING WITH OIL

D. A. Stuart Oil Co.—Completely revised edition of the Booklet "Grinding With Oil," a 20-page catalog and handbook of grinding information. Revamped to keep the metal-working industries abreast of rapid changes in grinding with oil, this booklet contains a good deal of data on the application of Stuart oils to precision grinding projects. Useful sections about selecting proper oils and grinding wheels, wheel marking systems, and a chart of standard wheel shapes make this booklet a "must" for the grinder's pocket. Tips for handling grinding oils are listed for the convenience of the operator.

150 TECHNICAL BOOKS

Macmillan Co.—New 1948–49 descriptive Catalog of technical and engineering books. Gives full details, with tables of contents in most cases, about our standard, recent and forthcoming books on aeronautics, chemical technology, electronics, electrical engineering and radio, industrial management, machine and tool design, metallurgy, plastics, sanitary engineering and hydraulics, structures, shop work, etc.

151 HERRINGBONE GEAR SPEED REDUCERS

Brad Foote Gear Works—32-page Catalog No. 115 of Herringbone Gear Speed Reducers. Shows dimensions and ratings on single, double and triple reduction herringbone gear speed reducers—contains selection information, lubrication data and directions for use of tables.

152 FLEXIBLE COUPLINGS

Thomas Flexible Coupling Co.—The latest engineering information on Thomas Flexible Couplings is contained in their Engineering Catalog, which shows their complete lines of single and double types of All Metal flexible couplings for heavy duty impulse loads such as Diesel driven Compressors, as well as for smooth loads such as motor driven centrifugal pumps.

153 FLOATING DISC CLUTCHES

Carlyle Johnson Machine Co.—Builders of machine tools, machinery, and designers of motorized products, should be interested in this new Catalog. Includes complete data, specification tables, installations of Maxitorq Floating Disc Clutches. Capacities to 15 H.P. at 100 r.p.m.; 8 sizes in standard models. Also Automatic Overload Release Type; Non-locking lever type; Ring type Driving Cups, Shifter Shoes and Studs.

154 FLEXIBLE SHAFTS

S.S. White Dental Mfg. Co., Industrial Div.—Has available a 12-page illustrated Bulletin No. 4501, describing S.S. White flexible shafts for remote control and for power drives. This bulletin contains basic engineering information and data on flexible shafts and how to select and apply them. While not as detailed as S.S. White's regular 260-page Flexible Shaft Handbook, contains much worthwhil e and handy flexible shaft nformation

CATALOG GUIDE

155 SELF-LUBRICATING BUSHINGS

Graphite Metallizing Corp.—New Booklet, "Graphalloy Bushing," describes and illustrates the use of "Graphalloy" oilless bushings which need no oil. Widely used on equipment where usual lubrication cannot be applied. Application data is given for use at temperatures where oil solidifies and volatilizes, for bushings submerged in water, gasoline, weak acids and dyes.

156 FOAM RUBBER, SPONGE RUBBER

Sponge Rubber Products Co.—New 4-page Folder illustrates shapes and forms into which cellular rubber can be molded or die cut, tubing, cord, strips, sheets, rolls, pads. Describes typical applications in upholstering, sealing, insulating, gasketing, dust proofing, weather stripping, sound deadening, shock absorption. Offers experimental samples.

157 WORM GEAR SPEED REDUCERS

Cleveland Worm & Gear Co. — Bulletin "More Horsepower Per Dollar"—presenting a series of photographs and cost information on Speedaire Worm Gear Speed Reducers in different industries. Speedaire is a fan-cooled unit which will deliver up to double the horsepower of standard worm units of equal frame size at usual motor speeds.

158 BUSINESS SYSTEMS

Ozalid, Div. of General Aniline & Film Corp.—20-page illustrated Booklet "The Simplest Business System" explains how Ozalid machines can be used in the business office as well as drafting room. Contain 126 "short cuts"; shows how standard routines can be simplified; has time-saving ideas for all departments.

159 SAFETY EQUIPMENT—VALVES AND GAGES

Crosby Steam Gage & Valve Co.—New and completely revised illustrated Bulletins showing specifications and miscellaneous related data, attractively arranged to assist the engineer select proper safety equipment. Bulletin 108SV—Nozzle Type Safety Valves for Steam Service, 109RV—Nozzle Relief Valves for Liquid and Vapor Services in all Industries, 209-G Pressure Indicating Gages, Recorders and Testers.

160 SILICONE FLUIDS

Dow Corning Corp.—New 36-page Booklet describing DC 200 Silicone Fluids by Dow Corning presents physical, chemical, dielectric, and lubricating properties to help engineers evaluate these remarkable stable fluids as damping and hydraulic media, liquid dielectrics, lubricants, additives and impregnants. Graphs and tables show relative volatility, vapor pressure, viscosity-temperature relation, shear resistance, solubility, dielectric properties, compressibility, sound and light transmission.

161 INDUSTRIAL TRUCKS

Industrial Truck Div., Clark Equipment Co.—Featuring a tabulated summary of principal specifications of its fork-lift trucks, towing tractors and tructractor models, a new 4-page condensed Catalog has been issued. Dimensions, weights, capacities, and turning radii are given for all models, both gas-powered and electric battery-powered.

162 CENTRIFUGAL PUMPS

Peerless Pump Div., Food Machinery & Chemical Corp.—General purpose horizontal centrifugal pumps, designated as Type A, for handling water and light alkaline fluids are described in a new 20-page Bulletin. Pump sizes run from 1¼" to 48", handling capacities from 5 to 60,000 g.p.m., against heads to 500 feet, with temperatures up to 200 F. Pumps are of double suction, single stage, horizontal split-case design. Bottom suction and single suction designs are available in limited number of sizes.

163 UNION SPECIALTIES

Jefferson Union Co.—Illustrated Bulletin fully describes the "Recessed Seat" which is an exclusive feature of these unions, together with the advantages which result from this design and construction. Types of unions described include: 90° Union Elbows, 45° Union Elbows, Union Tees and Convenience Unions. Full range of sizes are contained in this literature; recommended pressure is also specified.

164 SEAMLESS WELDING FITTINGS AND FORGED STEEL FLANGES

Tube Turns, Inc.—Chart of Pipe and Fittings Materials. Quick-reference chart covering ASTM and other specifications, Chemistry, Service Temperature Limits and Welding Data on carbon, inter-

Continued on Page 58

mediate alloy, stainless and special analysis steels. Dimensional Data and Weights. Folder of man-size tables giving dimensional information on Tube-Turn welding fittings from 1/2" to 30" in standard weight and extra strong, and flanges in all sizes and weights. Allowable Working Pressures. Booklet of pressure tables covering complete line Tube-Turn welding fittings for Power Piping, Oil Piping, Heating Piping, Gas Piping, Refrigeration Piping.

165 SPEED REDUCERS

Winfield H. Smith Corp.—Just issued a new pocket size Catalog No. 148 describing and illustrating their complete line of Worm Gear, Helical Gear and Differential Speed Reducers. In the line are sizes and styles for practically every speed reduction application. In addition to the data about speed reducers there is included helpful information on selecting the reducer, construction, overhung loads, lubrication, chain pull factors and flexible couplings. Another valuable section covers a very complete collection of engineering information—formulae, tables and charts.

166 HYDRO-SHEAVE DRIVE

Twin Disc Clutch Co.—4-page Folder describes new Hydro-Sheave Drive, designed for use with Worthington QD Sheaves on small gasoline engines and electric motors in the 3/4 to 25 hp range. Hydro-Sheave Drive, a hydraulic power transmission incorporating the Twin Disc Small Hydraulic Coupling, permits unit to be selected on basis of running load . . . provides smoother operation . . . prevents stalling.

167 STAINLESS STEEL SHEETS

Armco Steel Corp.—"Design Data on High Tensile Stainless Steel Sheets for Structural Purposes" is a 38-page Technical Book produced to aid designers in computing structural specifications. The first section of this book interprets the properties of "Armco" High Tensile Stainless Steels, and explains some of the fundamental concepts of design theory to be considered when using these materials at the high stress levels where they are most effective. A section on "Significance of the Secant and Tangent Moduli of Elasticity in Structural Design"—discusses the designing of beams and columns of structural materials that have no well-defined yield point, and which must be used above their proportional limits to be useful.

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168 CENTRALIZED LUBRICATION SYSTEMS

Farval Corp.—"Studies in Centralized Lubrication 1948"—presenting a series of case studies. Farval is a positive mechanical method of delivering oil or grease under pressure to a group of bearings in exact measured quantities. Eliminates guess work of hand lubrication and insures constant operation of machines without shutdown to lubricate or for bearing repair.

169 SCREW THREAD INSERTS

Heli-Coil Corp.—Bulletin No. 248 has just been released. It embodies extensive data regarding design, specifications and installation of Heli-Coil-Screw Thread Inserts. These Inserts are made of stainless steel (in some cases phosphor bronze) and are inserted in tapped threads in light metals and other non-ferrous and ferrous metals to provide a hard, long-wearing surface for the tapped thread. Heli-Coil Inserts are also used in plastics, wood and many other structural materials for the same purpose. In addition to their use as original equipment, they are widely applied in salvage and maintenance operations. This bulletin has been prepared for designing engineer to aid him in applying Heli-Coil Inserts in new products or in the re-designing of old products. For this purpose, it is filled with practical and useful information.

170 MACHINE DESIGN SHEETS

Lincoln Electric Co.—A series of single page Sheets, punched for notebook filing, giving the fundamentals through concrete illustration of the correct approach to welded design. Current series tells how to design for welding the basic elements of machinery such as wheels, levers, brackets, bases, containers and covers. Mailed periodically.

171 CONVEYOFLO METERS

Builders-Providence, Inc.—Complete Catalog fully illustrating and describing their Conveyoflo Meter—the flow meter for dry materials. Gives complete description of the operation of the Conveyoflo as well as typical installation diagrams illustrating the installation of the Conveyoflo Meter in existing belt conveyors and also a complete self-contained conveyor unit. Flow diagrams show how the Conveyoflo can automatically proportionately control the feeding of secondary ingredients either dry or liquid.

172 PIPE HANGERS

Grinnell Co.—90-page Catalog of malleable, cast, wrought, steel and spring hangers has been arranged to simplify the selection of complete hanger assemblies. Contains helpful information for making spring hanger load calculations. Abundant miscellaneous material makes it an essential reference volume.

173 INDUSTRIAL VACUUM CLEANING EQUIPMENT

U. S. Hoffman Machinery Corp., Air Appliance Div.—New 4-page Booklet A-706 describes the wide number of applications for Hoffman heavy-duty portable and stationary systems in increasing production, improving product quality, reducing maintenance costs and promoting better plant safety, cleanliness and employee morale. A guide to the selection of right equipment for specific plant requirements is included.

174 STEAM BOILERS—STEEL PLATE FABRICATION

Fitzgibbons Boiler Co.—General Catalog of entire line of Fitzgibbons Boilers. 62 years' experience. ASME Code and Non-Code Pressure Vessel and Non-Pressure Vessel fabrication. Rolls, shears, presses, drills, punches, hydrostatic testing, resident Hartford Inspector. Heavy work especially.

175 LIQUID LEVEL GAGES

Jerguson Gage & Valve Co.—Data Unit 72 describes complete line of liquid level gages, valves and specialties. Includes Process Gages, Special Application Gages and High Pressure Steam Gages. Gages are Flat Type Reflex and Transparent as well as Tubular Type. Includes Flanged End Gages, High Pressure Gages up to 20,000 psi test pressure, Heated or Cooled Gages, Non-Frosting Gages, Distant Reading Gages and Water Columns.

176 TURBO PUMPS

J. S. Coffin, Jr., Co.—Bulletin S illustrates compact centrifugal pumps with integral steam turbines,

CATALOG GUIDE

lists services, maximum ratings, and data for proposal; shows how destructive casing erosion-corrosion and interstage leakage are avoided; describes governing gear which reduces and restores speed with loss and recovery of suction, with wide range sensitive constant pressure control.

177 INJECTION MOLDING MACHINES

Watson-Stillman Co.—Folder and Inserts totaling 10 pages, Bulletin 620-E, describing the "Complete-line" of Watson-Stillman injection molding machines; complete dimensions and specifications for 14, 18 and 32 ounce capacity machines. Also detailed information from the same company about its new 40- and 80-ounce machines for large capacity molding.

178 FELTAN

American Felt Co.—Unique non-skid and surface gripping power is claimed for a new microporous sheet material recently announced under the trade name "Feltan." Commercially available types of "Feltan" include natural rubber and neoprene modifications of felt which, after chemical treatment, produce a microporous leather-like material. All types are furnished in cut-part form or in continuous lengths up to 20 yards, 36 inches wide. Thicknesses range from 1/32 inch to 1/8 inch. Typical uses include base coverings for precision instruments and electrical appliances, roll coverings, non-skid vibration mountings and resilient gaskets.

179 ELECTRIC MOTORS

Century Electric Co.—Complete line of Polyphase Motors from 1/6 to 400 horsepower is illustrated in Literature Form Nos. 344A and 643. Single Phase Motors are illustrated in form Nos. 649, 648 and 0411.

180 UNIT STEAM GENERATORS

Preferred Utilities Manufacturing Corp.—Bulletin 1000 describes in detail the Preferred Unit Steam Generator—a heavy duty, self-contained, oil fired, portable steam plant embodying in one compact unit all the equipment necessary to generate steam economically. Among the engineering features discussed are the four pass down draft gas travel, induced draft, low furnace, heavy construction and fully automatic operation even with Bunker C and No. 6 oil.

181 WIDE RANGE MECHANICAL ATOMIZERS

Engineer Co.—Bulletin describing the "Enco" Wide Range Mechanical Atomizing type Fuel Oil Atomizer. Operates with the maximum oil pressure available to insure the most efficient atomization over the entire load range. It is no longer necessary to cut burners in and out of service, change sprayer plates or return the oil not required. Better heat distribution in the furnace is possible at any load ranges.

182 ELEVATED STEEL WATER TANKS

Chicago Bridge & Iron Co.—20-page Bulletin describing welded elevated water tanks built in standard capacities of 15,000 gallons to 500,000 gallons capacity to provide gravity water pressure in municipal water systems or for general service and fire protection at industrial plants. Illustrations of seven representative sizes of elevated tanks reproduced in full color. Elevated tanks provide dependable pressure and reduce operating costs. Modern welded construction gives them streamline appearance and make them easy to maintain.

183 GASOLINE ENGINES

Gladden Products Corp.—Circulars describing Bee-Line engines, Models AB, 40, 50, and 75, for commercial and Marine applications give specifications and dimensional data. They are compact, powerful, 4-cycle, single cylinder, air cooled, pretested and proven engines.

184 FOUR-CYCLE, AIR-COOLED ENGINES

Clinton Machine Co.—A new Brochure showing, in addition to its "700 Series" 1 1/2 to 2 H.P. and "1100 Series" 2 1/2 to 3 H.P. engines, the applications of its new "500 Series" 3/4 to 1/2 H.P. engine. These are 4-cycle, air-cooled engines, in four different type models, standard, gear reduction, kick starter and thrust bearing. Also available with brochure are specification sheets showing various types of shaft extensions, power and torque curves with power data. It also shows various applications on which the engine is being used, with a complete list of other uses to which the engine can be put.

185 WEIGHING SCALES

Yale & Towne Mfg. Co.—New three-color Technical Bulletins—totaling 68 pages of data, diagrams, selection advice, and practical information on dial

Continued on Page 60

BUYER'S CATALOG GUIDE

scales. These bulletins are devoted to country scales, bench scales, portable platform scales, dormant platform scales, crane scales and weigh-can installations. These bulletins are of value to production managers, traffic men and others throughout industry who are interested in highspread accurate weighing to measure and control the flow of goods.

186 STEAM GENERATORS

Cyclotherm Corp.—Cyclotherm Steam Generators and the Cyclonic Combustion principle are described and illustrated in two-color diagrammatic sketches in the new Bulletin P-1 entitled, "Years Ahead in Economical Steam Generation." Cyclotherm units for oil, gas or interchangeable firing are included as well as tables giving output in Pounds of Steam per Hour and Equivalent Direct Radiation for all size boilers.

187 DROP FORGINGS

Drop Forging Association—Revised edition "Metal Quality—Hot Working Improves the Properties of Metal." This new 64-page Booklet issued by the Technical Committee of the Drop Forging Association for users of forgings—design engineers, metallurgists and production and management executives. The booklet describes and illustrates the development of metal quality progressively throughout hot working operations, from the blast furnace to the finished forging. A discussion is presented of forging quality steel and the proper selection of metals for forgings. Steps in making forging dies and the various methods of hot working metal by forging are reviewed. Forging procedures of various kinds of parts are outlined such as parts with thin sections, projections holes, etc. Economic advantages of forgings are highlighted.

188 PERMANENT MAGNETS

General Electric Co.—8-page illustrated Bulletin No. CDM-12 describing G-E metallurgical products. This bulletin is devoted to a description of G-E cast and sintered Alnico, Cunife, Cunico, Vectolite, Silmanal, and various permanent magnet holding assemblies. Special alloys such as G-E Thermistors and G-E Hevimet are also discussed.

189 STOKERS

Detroit Stoker Co.—Bulletins covering complete line of Detroit Underfeed and Overfeed Spreader Stokers. Detroit Stokers are unsurpassed for their economy and dependability. Features embodied in the various designs represent over fifty years of experience in stoker manufacture exclusively. As builders of both underfeed and overfeed spreader stokers of many types, sizes and capacities, they are in a position to recommend the kind of stoker best suited for any individual requirement. All grades of bituminous coal are successfully burned without expensive preparation. Operating costs are low, plant efficiencies may be raised to new standards and the capacities of present boilers increased through the use of Detroit Stokers. Proper design and application by experienced builders will produce best results.

190 CONTINUOUS BLOW-DOWN

Henszey Co.—"Complete, Automatic Control of Boiler Water Concentration Without Heat Loss" is the sub-title to a new 4-page illustrated Bulletin. Discusses boiler impurities. . .how they are formed, why they should be removed, and how to remove them. Points out advantages of automatic, continuous blow-down and the accompanying savings in heat, water, equipment, and labor.

191 MATERIALS HANDLING EQUIPMENT

Lewis-Shepard Products, Inc.—Catalog No. 23, 86-page, four-color catalog of most diversified line on the market. Five sections: Fork Trucks; "Jack-Lift" Electric Trucks; Hand and Electric Stackers and Cranes; Mechanical Hand Lift Trucks (single stroke; multiple stroke; hydraulic); Floor Trucks, Skid Platforms, Pallets, Storage Racks—plus variable application equipment. Striking cover, plastic bound, quick reference tab. Since publication, company has announced its electric tiering truck—the "JackStacker."

192 AUTOMATIC CONTROLS

Mercoid Corp.—A complete line of automatic controls and mercury switches are illustrated and described in Mercoid Catalog No. 600A. These electrically operated controls cover a wide range of applications involving the automatic control of pressure, temperature, liquid level and for lever arm mechanical operations. Various types of mercury switches are made in numerous circuits.

193 MULTUPLEX PUMPS

Aldrich Pump Co.—New 12-page Catalog, Data Sheet 67, contains complete details on Aldrich Inverted Multiplex Pumps including the Aldrich Triplex, Quintuplex, Septuplex and Nonuplex. It includes numerous photographs, pump dimension drawings and easy-to-read pump selection charts for selecting the type and size pump required for varying operations. Of particular interest to users of more than one high pressure pump are two sections dealing with interchangeability of parts on 6", 7", 7½" and 8" stroke Multuplex Pumps.

194 ANCHOR CHAINS

Baldt Anchor, Chain & Forge Div. of Boston Metals Co.—The Story of "Di-Lok," the strongest Anchor Chain known.

195 POWER PLANT EQUIPMENT

Schutte & Koerting Co.—In a four-color diagrammatic Layout of a high pressure power plant the application of numerous types of power plant equipment is illustrated. Eight-color combinations are used to differentiate between steam, exhaust steam, condensate, water, raw water, fuel oil, lubrication oil and air. Equipment such as valves, eductors, syphons, rotameters and heat transfer apparatus is shown in white against a dark brown background.

196 PACKAGED, AUTOMATIC STEAM GENERATORS

C. H. Dutton Co.—General description and specifications of Dutton Econotherm Steam Generator, both the "Deluxe" Model 30 and the new Series 40. In the new Series 40 Econotherm height has been materially reduced. New Folders show Boiler Design, Specifications, boiler feed pump construction, condensate return systems and special features such as induced draft, rotary combustion chamber, off-center burner, steady water gage and other details of design and construction as well as controls and installation. These folders also show data on burner assemblies for all common types of fuel, induced draft fan capacities and all necessary information to reduce cost of installation to a minimum.

197 BLIND RIVETS

Cherry Rivet Co.—A 2-page Folder (4K-2) describes the self-plugging and pull-through type Cherry Blind Rivets. It is suitable for designers and production planning departments. . .showing typical applications of these two standard type blind rivets, their range of sizes, and the automatic tools required for their installation.

198 HYDRAULIC VALVES

Gerotor May Corp.—Catalog Section 201 contains complete data on 4-way hydraulic control valves, for oil service up to 1500 and 3000 p.s.i. Standard, spring-return, spring-centered and ball-detent action. 5 piston sizes for any hydraulic circuit. Also data on newly improved relief valve which operates without chatter.

199 WEIGHT PRINTING SCALES

Toledo Scale Co.—A 40-page Catalog showing the variety of Toledo Printweigh Scales designed to eliminate human errors in recording weights in materials received, processed, or shipped. Available for all varieties of Toledo Industrial Scales. These include ticket, sheet and strip recording types; also accessories including selective numbering identification.

200 SPEED REDUCERS

Abart Gear & Machine Co.—New Catalog illustrates and describes with photographs and diagrammatic drawings full line of Abart Speed Re-

Read the various items listed . . . one catalog may hold the solution to your present problem . . . select those items of interest to you by number . . . fill in coupon on page 43 and mail promptly.

CATALOG GUIDE

ducers, worm, spur and combinations, for all duties from 1/10 to 417 h.p. Complete engineering data make the book valuable to have at hand for ready consultation. Catalog also carries detailed information on Abart Gears, spur, bevel, worm, worm wheels, helical and spiral, internal, cut to specifications from any gear material. No stocks are maintained.

201 LOAD-GRAB ATTACHMENT

Hyster Co.—Illustrated Catalog No. 1099 details the palletless materials handling applications of the Hyster Load-Grab, new hydraulic attachment for use with the Hyster "20" and "40" Lift Trucks. In addition to the standard steel arms which squeeze-grip a load for lifting without the necessity of pallets, several optional arms are described such as: spike-faced tines for clutching wooden boxes and crates; rubber-faced arms for particularly gentle handling; and drum handling arms for transporting from one to three drums at a time.

202 HEATING-DIRECT FIRED UNIT TYPE

Prat-Daniel Corp.—New 8-page Catalog No. 300 on the "Thermobloc" direct-fired unit heater for factories, hangars, warehouses and other industrial properties. Detailed description given of the "Thermobloc" heater with ample illustrations. This heater is of a standard size producing 550,000 btu's per hour in a well styled unit 30" in diameter and 10' high. The advantage is shown of placing a number of such heaters throughout a plant rather than using expensive duct work for heated air. Oil, gas, or automatic coal firing may be used for the generation of the heat which is directly transfered to heated air for circulation to the working level. The unit may be used in summer time for air circulation of the cold air near the floor to the working level.

203 HYDROMATIC SINGLE CONTROL VALVES

Cochrane Corp.—New Bulletin No. 4460 describes the Hydromatic Single Control Valve, now standard equipment on Cochrane Zeolite Softeners and Pressure Filters. With the Cochrane Hydromatic Valve, all the normal functions of a valve nest are integrated and controlled by one valve.

204 ROTARY PUMPS

Kinney Mfg. Co.—An attractive new Catalog, L48, describing rotary liquid pumps has just been released. The 44-page bulletin is fully illustrated and shows rotating plunger pumps, heliquad rotary pumps, and strainers to handle a wide range of viscous and non-viscous liquids. Useful engineering information is included for reference, with pumping data, viscosity charts and conversion tables.

205 WELDER'S HANDBOOK ON CLADS

Lukens Steel Co.—Practical information on all phases of clad steel fabrication—forming, welding, heat treating and finishing—is presented in the Manual, "Fabrication of Lukens Clad Steels," just published. A handy, pocket-size reference book for engineers and welders, it gives clear, shop-tested information on the experience of scores of fabricators who have pioneered in the design and fabrication of clad steel equipment for more than eighteen years. It is profusely illustrated throughout with photographs, drawings and charts detailing each operation. 90 pages.

206 LEADED BRONZES, BRONZE WEARING PARTS, BRONZE SEALS, ETC.

American Crucible Products Co.—Folded Pamphlet, "The Engineered Bronze," showing "Promet" Bronze mixes, physicals, etc. Also, folder showing "Promet" lead-base babbitt; also, folder, "Completely Machined Parts to Customers' Specifications," showing pictures of plant and other general information. Also, folder "Promet for All Coal Mining Equipment." Also actual photograph of "Promet" parts.

207 AXIAL FLOW FANS

Aerovent Fan Co.—11th Edition Catalog describing Aerovent "Macheta" Axial Flow exhaust and ventilation, 9" to 144", direct connected, belted, extended shaft, mancooler, pulley, duct and belted duct fans. Write for additional descriptive literature. Prompt personal attention given to all inquiries. One of their competent sales engineers, located at important points throughout the United States, will be glad to contact you.

208 CONVEYORS

Jervis B. Webb Co.—Overhead Trolley Conveyors Catalog contains illustrations, line drawings and specifications covering complete line of overhead conveyor equipment with descriptive matter for ready reference. Bulletins are also available on the following subjects: Power and Free Conveyors, Webb Hand Pushed Trolleys, Webb Dowmetal

Continued on Page 62

Gravity Roller Conveyors and Webb Portable Safety Roller Skid Conveyor.

209 TECHNICAL BOOKS

The American Society of Mechanical Engineers—1949 Catalog of A.S.M.E. Publications. A 20-page descriptive price list of current books, standards, codes, research reports, and periodicals published by the Society.

210 WELDING FITTINGS

Taylor Forge & Pipe Works—Taylor Forge Bulletin 476, Stainless Steel Dimensional Data, describes welding fittings from 3/4 inch to 12 inches, and light-weight American Standard flanges from 3/4 inch to 30 inches, all available in stainless types 304, 316 and 347, monel, inconel, nickel, copper and other usual industrial metals.

211 STEAM GENERATORS

Cleaver-Brooks Co.—"Get Fast, Low Cost Dry Steam With the Cleaver-Brooks Packaged Power Steam Generators" is the title of a newly revised general industry Bulletin, describing the installation and operating advantages of the above units. This book contains a description, typical applications and specifications of the units, available in 17 sizes, 15 to 500 h.p. with design pressures from 15 to 200 p.s.i.

212 HYDRAULIC HIGH PRESSURE CONTROLS

Hydropress, Inc.—Folder describing Hydraulic Control Valves, custom-built to individual shop requirements. The folder deals with all kinds of Hydraulic Control Valves, Prefilling Valves, Stop Valves, Check Valves, By-Pass Valves, Shut-off Valves for Accumulators and any combination of valves for Sequence operation.

213 DEEP DRAWN SHAPES AND SHELLS

Pressed Steel Tank Co.—General Catalog and Bulletins describing cylinders for propane, butane, anhydrous ammonia, chlorine, refrigerant gases and numerous other gases. Also illustrates barrels, drums, containers, air receivers and special packages. Text covers data on capacities, pressures, codes and materials.

214 VIBRATION FATIGUE TESTING MACHINES

All American Tool & Mfg. Co.—Bulletin 1007 on All American Vibration Fatigue Testing Machines. Fully describes, illustrates and gives specifications on models for every requirement. Explains the principles which make vibration fatigue testing with an All American machine authentic. Contains a representative list of users, which includes the leaders of American industry.

215 OIL SEALS

National Motor Bearing Co.—Catalog No. 101 lists National Oil Seals in all stock sizes and types. Listings are presented two ways: (1) by shaft diameter (I.D.) and (2) by stock number. Listings indicate proper housing bore and O.D. ratio, as well as width of oil seals. In addition, this catalog shows National Laminated Shims and Shim Seals, and Arrowhead Rubber Co. precision-molded synthetic-rubber parts. A basic feature of this catalog is a comprehensive study of proper oil seal installation methods, structural details, and typical applications.

216 ASH CONVEYOR EQUIPMENT

National Conveyors Co.—A Condensed Catalog is offered as a guide to assist you in selecting the proper type of ash conveyor to meet your individual needs. Capacities in tons per hour and arrangement of equipment for various types of boiler settings are illustrated. The systems described are suitable for both large and small power plants. In addition, this catalog contains information on the special conveyors manufactured by them for crushed metal turnings. See their advertisement in A.S.M.E. Mechanical Catalog.

The "Buyer's Catalog Guide" offers readers of MECHANICAL ENGINEERING an opportunity to secure the latest industrial literature available. In this issue there are 216 items to make selections from. For convenience an index may be found on pages 41 and 43. Select desired catalogs by number, fill in coupon on page 43 and mail promptly. *(Must be mailed on or before date given on coupon.)*

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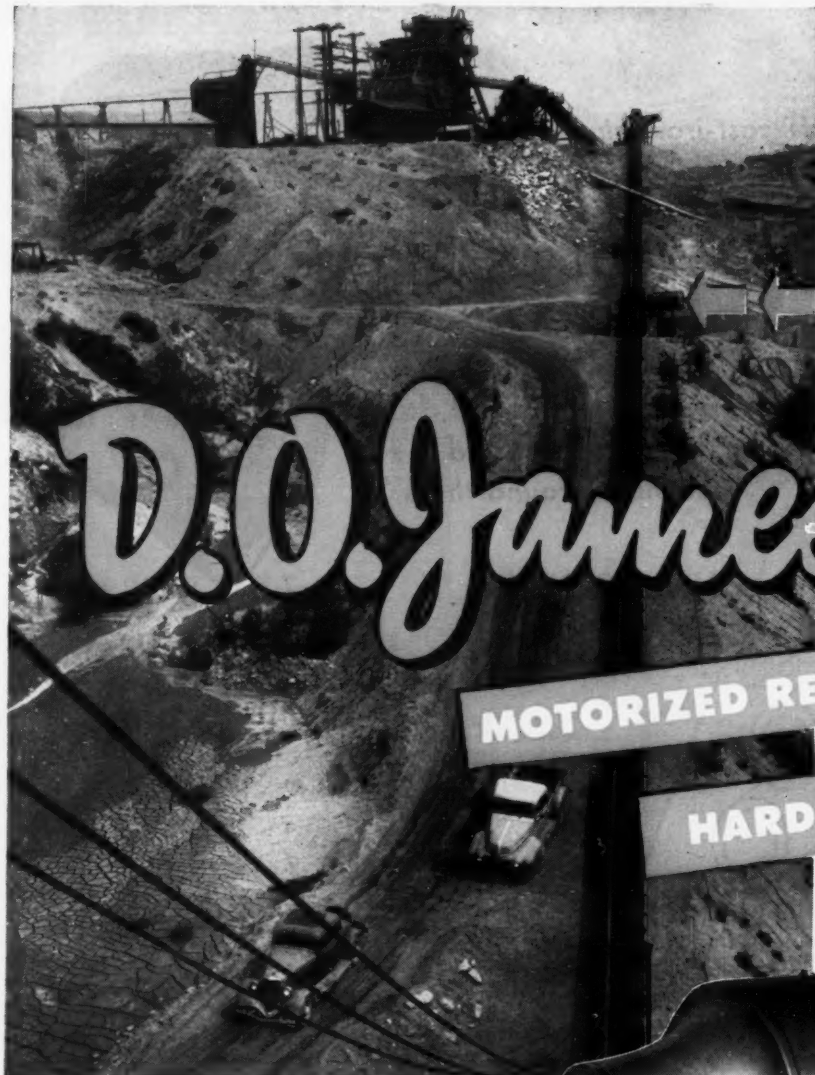

D.O.James Motorized Reducer, size 202M, 60 horsepower, 90 R.P.M.—using Howell totally enclosed fan cooled motor—driving large belt conveyor.

D.O.James

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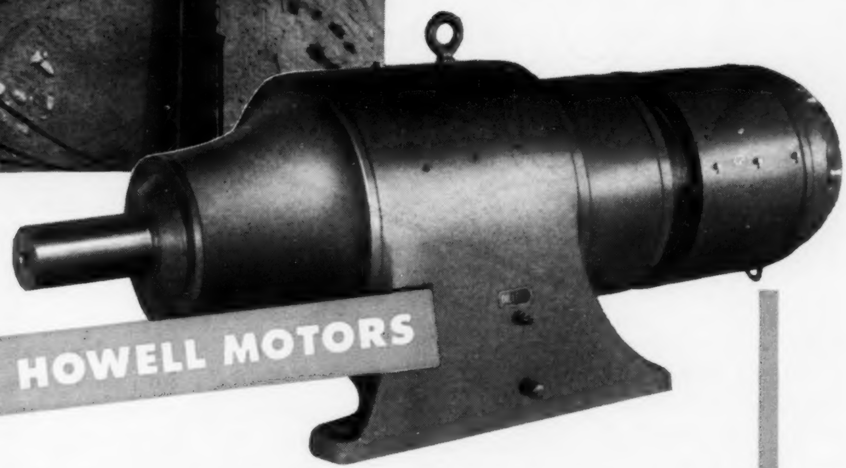

WITH HOWELL MOTORS

D.O.James Motorized Reducer, the centrally balanced drive with great emergency strength, is an important factor in this rock moving job. The conveyor belt, driven 350 feet per minute, moves 550 tons of rock an hour—*really making the hard jobs easy.*

This simplified assembly, using Howell standard flange type motors, coupling connected with high speed pinion gear shaft makes for greater accessibility.

Howell Precision-Built Motors are the product of Howell Electric Motors Company, Howell, Michigan—Makers of Quality Motors Since 1915.

D.O.JAMES GEAR MANUFACTURING COMPANY

Since 1888—Cut Gears • Gear Reducers • Flexible Couplings

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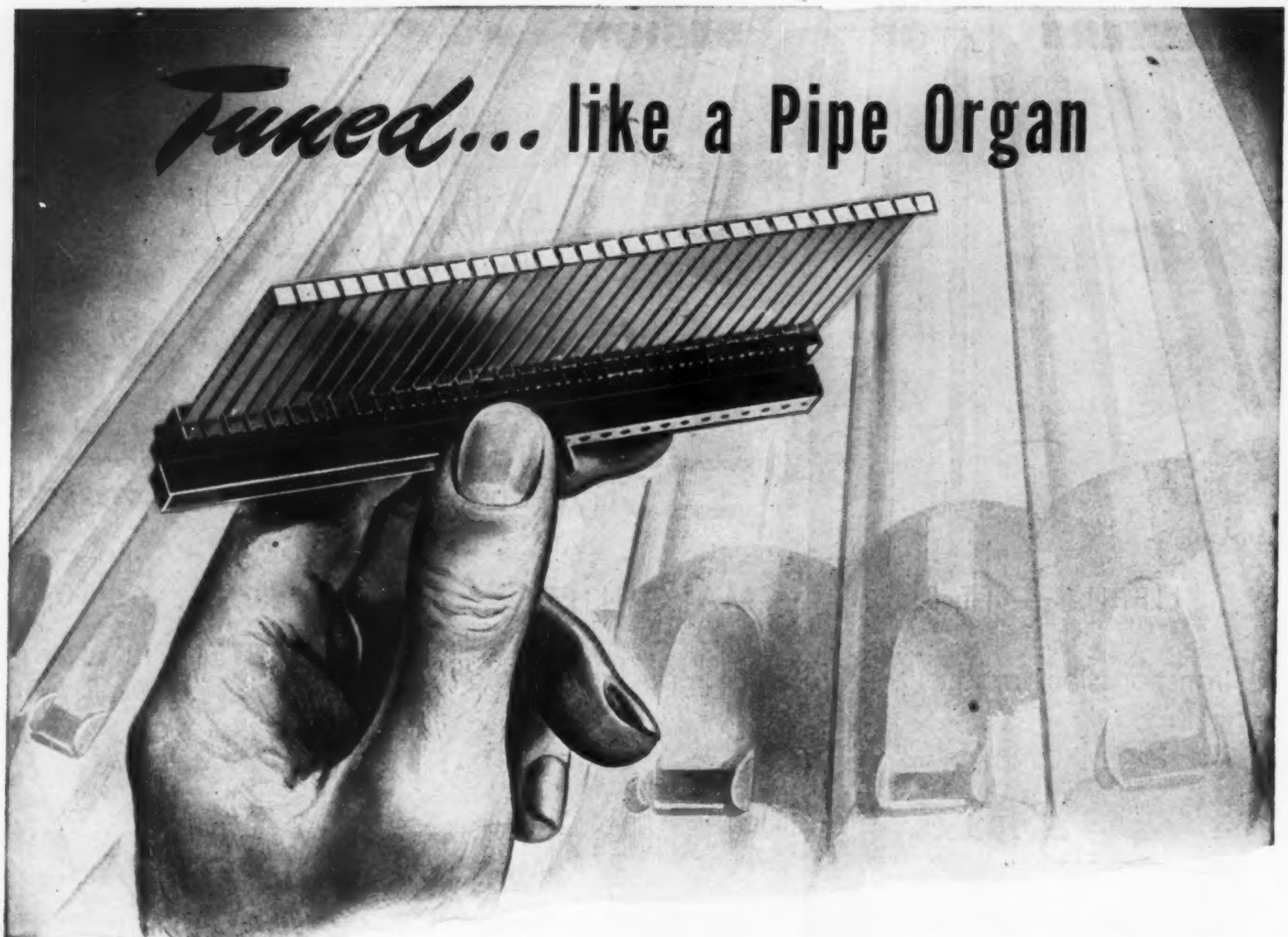
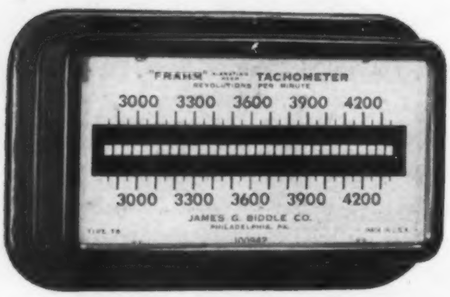


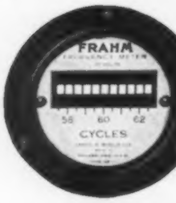
The resonant-reeds in Frahm instruments are even more simple, accurate, trouble-free and long-lived than the pipes in an organ. There is literally nothing to wear or get out of adjustment. They are permanently tuned for the life of the instrument and each reed responds to its own vibrational frequency, swinging unfailingly into resonant action.

There are three important applications of the Frahm Resonant-Reed principle:

1. *Tachometers,* that are mounted directly on turbines and other equipment—and require no belts, gears or electrical connections . . . also portable types for hand use. For speeds between 900 and 100,000 rpm or vpm. ***Bulletin 31-M.***
2. *Frequency Meters,* wherein the reeds are actuated directly by a small electro-magnet, and give instant indications of frequency between 15 and 500 cps. ***Bulletin 32-M.***
3. *Frequency-Sensitive Relays,* which operate on a given frequency impulse or upon slight deviation from a specified frequency. Particularly appropriate where a frequency impulse can be super-imposed, for example, on a d-c circuit—also used as a frequency monitor.

Correspondence on these and other applications of Frahm Resonant Reeds will be welcomed.





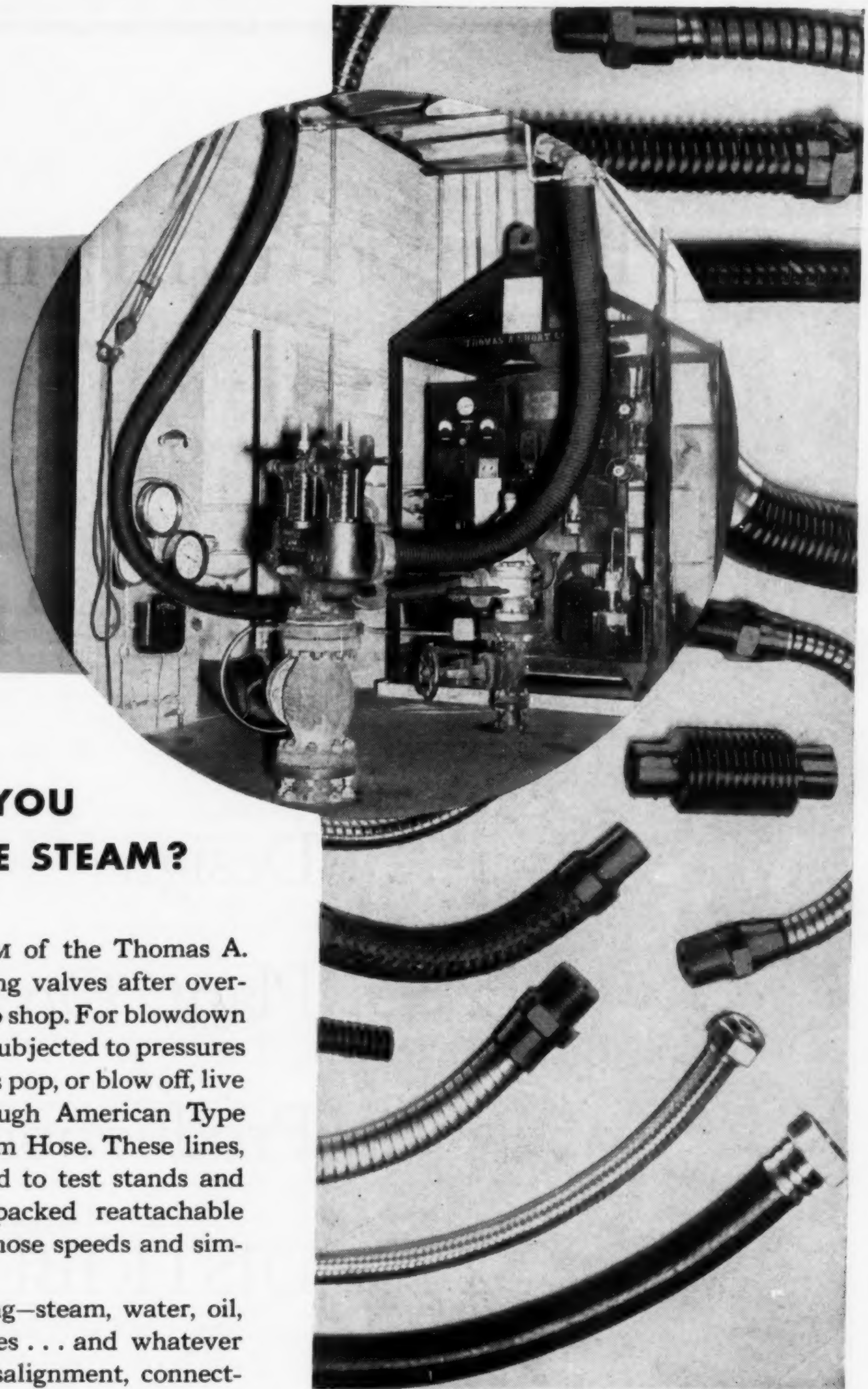
Shown above is the Frahm Tachometer for permanent mounting. To the left is the miniature type Frahm Frequency Meter for permanent mounting.

JAMES G. BIDDLE CO.

Electrical & Scientific Instruments

1316 ARCH STREET, PHILADELPHIA 7, PA.

When these valves *POP*



HOW WOULD YOU HANDLE THE LIVE STEAM?

THIS WAS THE PROBLEM of the Thomas A. Short Company in testing valves after overhauling in their San Francisco shop. For blowdown and pop-off tests, valves are subjected to pressures up to 600 lb. When the valves pop, or blow off, live steam is safely vented through American Type BD-15 Flexible Bronze Steam Hose. These lines, 3″ and 4″ I.D., are connected to test stands and rigid exhaust stacks with packed reattachable couplings. Flexibility of the hose speeds and simplifies the testing job.

Whatever *you* are handling—steam, water, oil, solutions, semi-solids, or gases . . . and whatever your problem—vibration, misalignment, connecting moving parts, or piping in cramped places . . . American engineers can help you out. At no extra charge we will design connections to fit your job, complete with special end fittings attached. They'll serve you long and well.

Write for information about the many uses and types of American Seamless Flexible Metal Tubing and Flexible Metal Hose. Feel free to consult our Technical Department at any time.

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1 . . . Design

2 . . . Plant Operation

3 . . . Production

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Fundamental No. 4

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Distribution . . rides devious trails to many devious destinations. And being unable, so far, to follow the straight-line trail of production, Distribution eats up a bigger slice of the consumer cost.

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Complicated, yes; but so are the engineering problems of design and operation and production. And that is the basic reason why eminent engineers decided it would be a good thing to pool their interests and their skills and work together, co-operatively.

That was 68 years ago when the scattered engineering skills and experiences and accomplishments were first brought together under the co-operative banner of The American Society of Mechanical Engineers.

What has been accomplished by industry, through engineering, is brilliant history. What will be accomplished by industry in the future will also depend greatly on co-operative engineering.

Perhaps the scientific methods developed for industry can be paralleled in the fields of DISTRIBUTION. Believing that something of value can be contributed, The American Society of Mechanical Engineers has taken steps to give co-operative assistance.

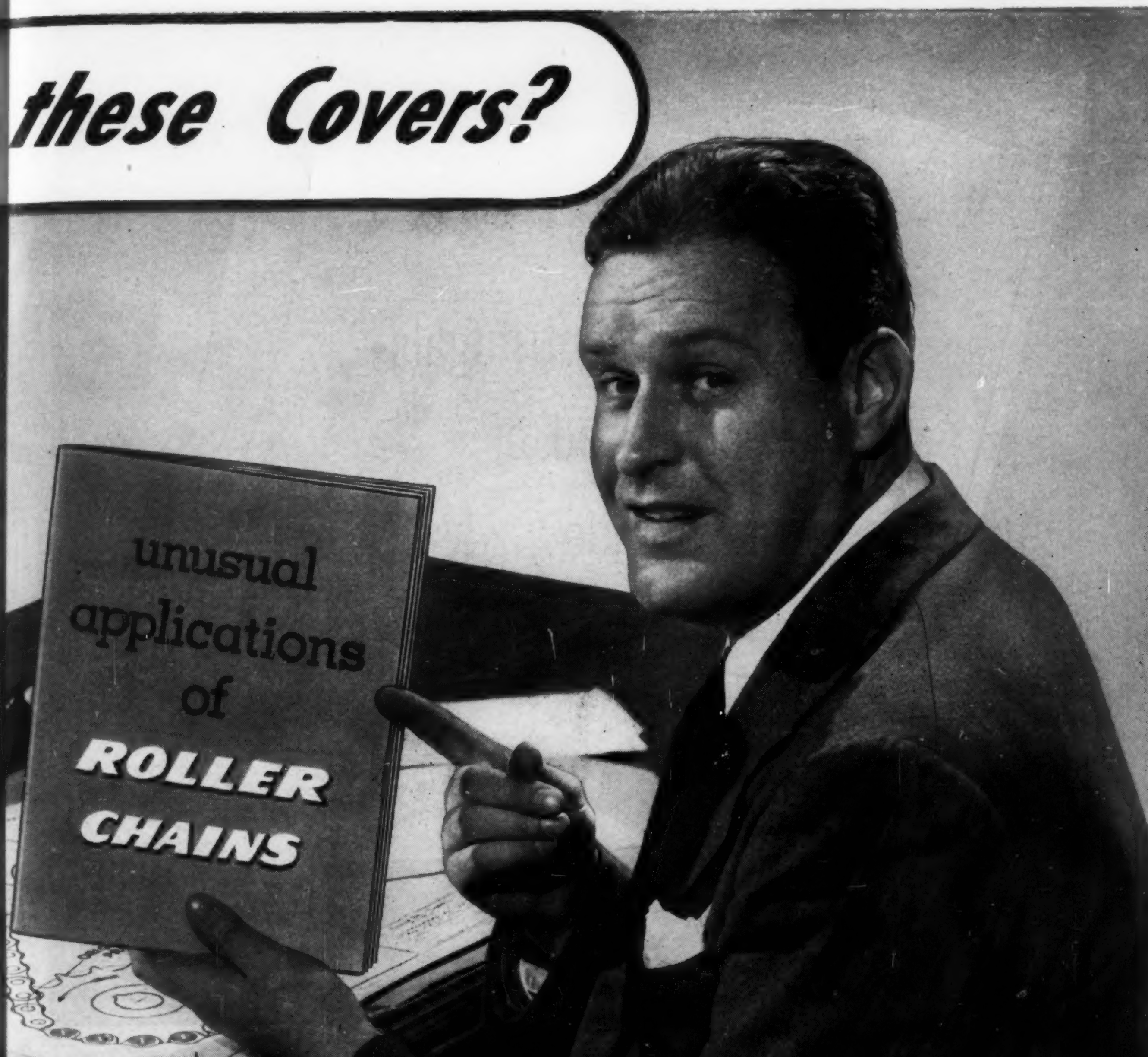
If anything of basic significance develops it will appear in MECHANICAL ENGINEERING . . the ASME publication whose authorship and readership are top-flight engineers and industrialists to whom basic developments in mechanical design, in plant operation and production practices, are paramount objectives.

Engineers and industrialists who look ahead and work ahead keep informed on basic engineering progress and industrial trends through the ASME publication . . MECHANICAL ENGINEERING.

The importance of these key men in industrial buying and specifying makes their basic publication, MECHANICAL ENGINEERING, important as a means of reaching them effectively and economically.

• • •

MECHANICAL ENGINEERING, *Published Monthly* by The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y., Midwest Office: 400 West Madison St., Chicago 6, Ill.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unusual
applications
of
ROLLER
CHAINS


Something NEW in HYDRAULICS
from Twin Disc
Users of small motors and internal combustion engines can now have all the advantages of fluid drive—at a very low cost. Twin Disc Hydraulic Engineers have designed a new hydraulic-conversion unit especially for small motors and engines. The new Twin Disc Hydro-Sheave Drive is a complete, easily-installed, low-cost transmission unit.
The Hydro-Sheave Drive is as easy to install as an ordinary sheave . . . sliding over the motor or engine shaft where it is held in place by three set screws. The unit is ready for immediate use . . . filled with hydraulic fluid . . . anti-friction bearings lubricated for life. Twin Disc Hydro-Sheave Drive is designed especially for use with Worthington QD (quick detachable) Sheaves, and is available in five sizes for use with any motor or engine in the ¾ to 25 hp range.
Built by the largest manufacturer specializing in friction clutches and hydraulic drives, Hydro-Sheave Drive is the simplest and most economical fluid power transmission available today. For complete information, including prices and the location of your nearest distributor, write to the Hydraulic Division for Bulletin 145. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).
Advantages of Fluid Drive
. . . smoother flow of power
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TWIN DISC
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Machine Tool Clutch
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Marine Gear
SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Yes, there is *no slidewire* in Dynalog* Electronic Potentiometers! In its place is a simple, variable capacitor. Here at last, is an ideal, continuous, *stepless*, balancing device . . . with sensitivity unlimited by the turn-to-turn steps of a slidewire winding. No moving contacts to wear or corrode. No gears, cables, or complicated mechanisms. Unprecedented high sustained accuracy and freedom from maintenance.

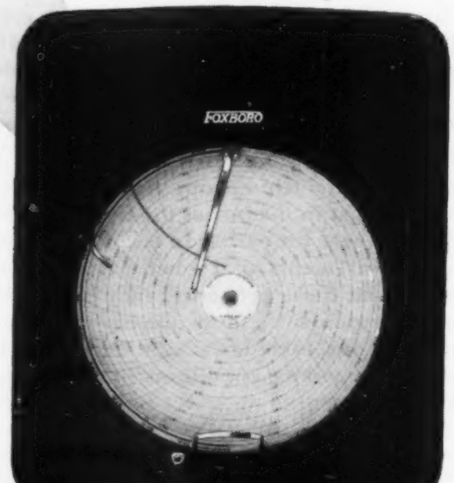
Naturally you anticipate better performance . . . *and you get it!* Sensitivity is one ten-thousandth (1/100 of 1%) of scale. Speed . . . full scale to complete balance in as little as 1 second—5 seconds standard. Accuracy . . . 1/400 or ¼ of 1% of scale. These and many other advantages of Dynalog Instruments are all the result of this entirely new concept in potentiometer design. Dynalog Instruments are available for measuring or controlling temperatures (with thermocouples or resistance bulbs), humidity, pressure, flow, force, etc. Get the complete story in Bulletin 427. Write **The Foxboro Company, 182 Neponset Avenue, Foxboro, Mass., U. S. A.**

**Reg. U.S. Pat. Off.*

Similar in design to the tuning element in your radio, this variable capacitor gives instant, automatic, stepless balancing.

Here's why DYNALOG Potentiometers set a new standard in freedom from maintenance

- *No Slidewire.*
- *No moving contacts.*
- *No high speed motor.*
- *No galvanometer.*
- *No batteries to standardize.*
- *No maintenance except occasional replacement of standard radio tubes.*
- *No gears.*
- *No knowledge of electronics needed.*



FOXBORO

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DYNALOG ELECTRONIC INSTRUMENTS

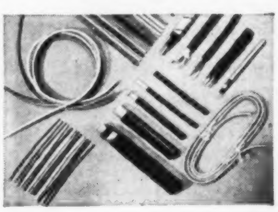
Digest

TIMELY HIGHLIGHTS ON G-E PRODUCTS

PHOTOELECTRIC RELAYS TO SPEED UP ROUTINE JOBS

Many routine processes can be speeded up by including these G-E photoelectric relays in your machine designs. They're used to control or limit a wide variety of operations, and to count, sort, or identify objects, especially delicate or freshly painted parts that can't be handled by mechanical fingers. They operate up to 600 times a minute on flashes of .001 of a second duration. Standard radio tube used has an expected life of several thousand hours. Any light source with at least five foot-candles at the photo tube can be used. See Bulletin GEC-279.

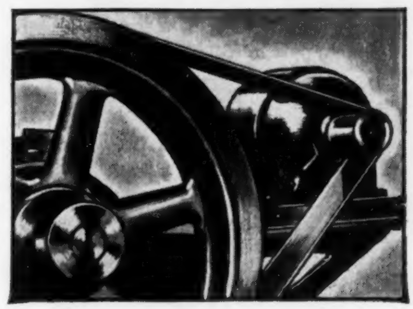
MORE CABLE IN LESS SPACE



Many a neat, space-saving design is made possible by the small diameter of Flamenol Style FL, G-E's famous low-voltage cable. Widely used for machine tool power and control circuits, it has both insulation and finish combined in a single synthetic covering. It is resistant to oil and moisture, acids and alkalies. Seven bright, permanent colors simplify and quicken circuit-tracing, save installation time. And Flamenol is flame-proof, cannot spread a fire. See Bulletin GEA-4352.

VERSATILE STARTING SWITCH "AT HOME" ANYWHERE

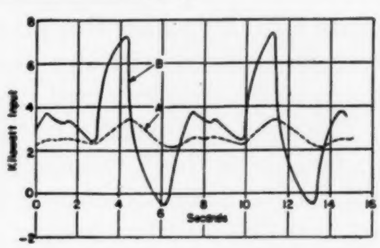
You can mount this newly-designed, hand-operated G-E motor-starting switch for fractional hp motors on or near machines of all types, in almost any location. Enclosures include general-purpose, dust-tight, water-tight types, and types for hazardous locations. Positive overload protection is provided by a thermostatic bi-metallic strip and heater device, which causes the switch handle to move to "Off" position when an overload occurs. All wiring terminals are on top of switch unit for easy accessibility, fast installation. See new Bulletin GEA-2234.



Slip the Overload to the Flywheel

On punch presses and similar flywheel-type machines, a G-E Tri-Clad Type KR high-slip motor slows down slightly as the peak load is applied. This allows the flywheel's stored energy to share the load, thus relieving the motor of severe overloads. You can specify smaller motor sizes and smaller and less expensive control. You also get an improvement in power consumption, less control and belt maintenance, reduced power peaks, and improved power factor. These G-E motors, with 5-8 per cent slip or 8-13 per cent slip, are made in both open and totally enclosed fan-cooled types. Open KR motors are available from 1 to 100 hp; totally enclosed KR motors from 1 to 50 hp. See Bulletin GET-1268.

Input curves of high-slip motor (A) and general-purpose motor (B) driving identical presses on identical work.



General Electric Company, Section D668-65
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

- ☐ GEC-227—Measurements review
- ☐ GEC-279—Photoelectric relays
- ☐ GEA-4352—Flamenol wire and cable
- ☐ GEA-2234—Fhp motor-starting switch
- ☐ GET-1268—High-slip motors

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WALWORTH LUBRICATED PLUG VALVES

offer these advantages

- ... Direct port opening
- .. Quarter turn opens or closes valve
- ... Dead tight shut-off
- ... Freedom from attack by fluids being handled
- ... Pressure sealed
- .. Made in a complete line. Sizes from ½" to 26" for pressures from 175 to 5,000 psi., and for vacuum requirements

THESE are just a few of the reasons why Walworth Lubricated Plug Valves give "top" performance on many *difficult* services.

All Walworth Lubricated Plug Valves employ special insoluble lubricants which protect the plug and body against contact with the line fluid, thus combatting erosion and corrosion.

The lapped surfaces of the valve are "pressure sealed" when the valve is in either the open or closed position. By turning the lubricant screw, lubricant is forced under high pressure through a grooving system that completely encircles the ports as well as the top and bottom of the plug.

The lubricant seals the valve against leakage, and reduces friction between plug and body. This permits easy, quick, full-opening, or tight shut-off with only a quarter turn of the plug.

Number 1700 (illustrated) is a Steel-iron valve, wrench operated, designed for a working pressure of 200 pounds WOG (water, oil, or gas). Valves are available in either screwed or flange types. Screwed type have API line pipe thread lengths. Flanged type (No. 1700F) is faced and drilled to American Standard for 125-pound cast iron flanges unless otherwise specified.

For further information about No. 1700 as well as the complete line of Walworth Lubricated Plug Valves, write for catalog.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

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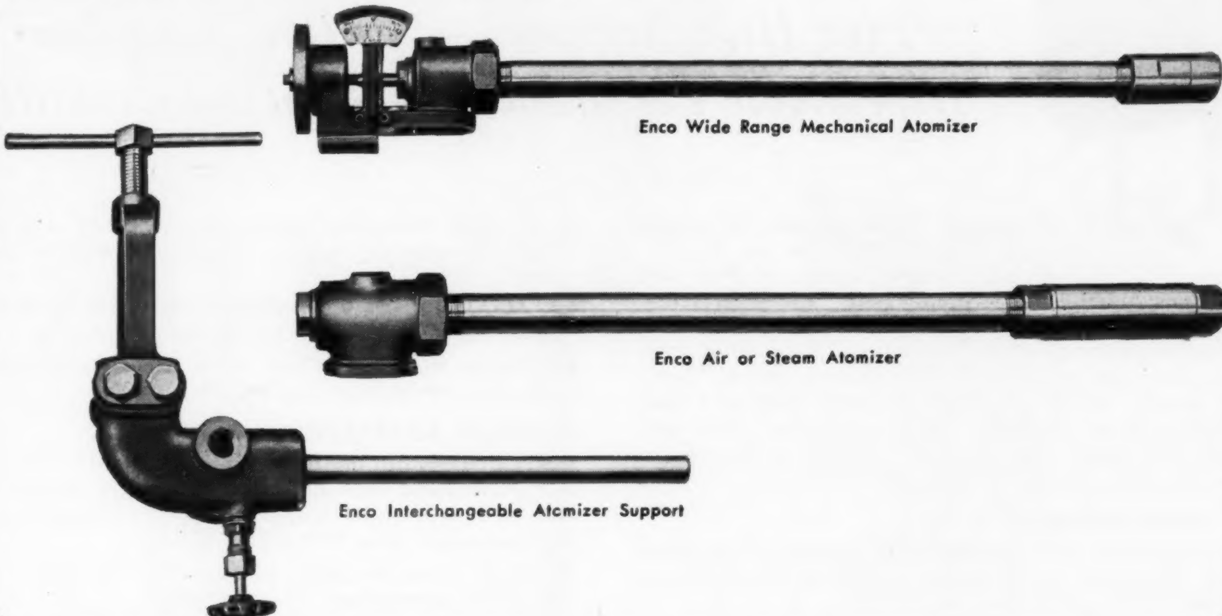
For Better Combustion Practice Use

ENCO INTERCHANGEABLE ATOMIZERS



Enco Wide Range Mechanical Atomizer

Enco Air or Steam Atomizer

Enco Interchangeable Atcmizer Support

Interchangeable Enco Fuel Oil Atomizers are improving combustion practice in more and more progressive boiler rooms. Designed for exceptionally wide capacity ranges with all grades of liquid fuels, they eliminate burner tip changes, through the entire load range.

1. *Wide Range Mechanical Atomizers*—With a capacity range of 10 to 1—controlled manually at atomizer or automatically from remote station—*constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.*
2. *Steam or Air Atomizers*—Capacity range of 10 to 1—controlled by manual or automatic pressure regulation.

Both atomizers are designed to fit the Enco Interchangeable Atomizer Support. Enco Straight Mechanical Atomizers are also available.

Enco Fuel Oil Atomizers are built to give most economical, efficient service for any type pulverized coal, gas or oil-burning air register as well as for stoker-fired and industrial type furnaces. They can also be used independently for special applications.

The Engineer Company maintains a research and planning staff to help you improve your combustion practice. Literature completely describing any Enco product will be sent on request.

EC-473

THE ENGINEER COMPANY
ALSO PRODUCES:
Enco Air Registers
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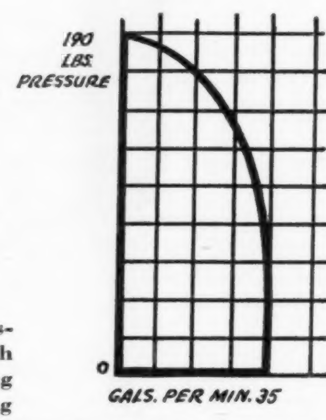
To make New, Better High Pressure, Low Capacity Pump

INDUSTRI-JET

GOULDS has combined a centrifugal and a jet or ejector type pump in one compact unit. This new pump gives you unique advantages in high pressure—low capacity applications.

RANGE



Nine Sizes, ¼ HP to 5 HP
Capacities: to 35 GPM
Pressures: to 190 lbs.

APPLICATIONS

FOR HANDLING { Cold or Hot Water, Alcohol, Kerosene, Carbon Tetrachloride and similar liquids

- General Water Supply
- Condensation Return
- Filter Press Service
- Air Conditioning
- Spraying
- Boiler Feeding
- Booster Service
- Air Refrigeration
- Hot or Cold Circulating Service

ADVANTAGES

IN PERFORMANCE

1. *Self Priming*—can't vapor lock. Once primed, always primed. The Industri-Jet automatically recovers prime even after suction is exposed to atmosphere.
2. *Built for continuous service.*
3. *Handles both wet and dry liquids.*
4. *Smooth, quiet operation—steady flow.*

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2. *Mechanical seal needs no attention.* Self-Adjusting for wear, requires no lubrication.
3. *Easy to inspect.* Entire pump can be disassembled without disturbing suction or discharge connections.

IN COST

Initial cost is low—and lower still when you consider quality construction and the many operating advantages.

GOULDS

Write Goulds Pumps, Inc., Seneca Falls, N. Y., for complete information on this new pump. Ask for bulletin 630-A1.

PUMPS, INC.

the PUMP FOR the JOB

A.S.M.E. GUIDE TO

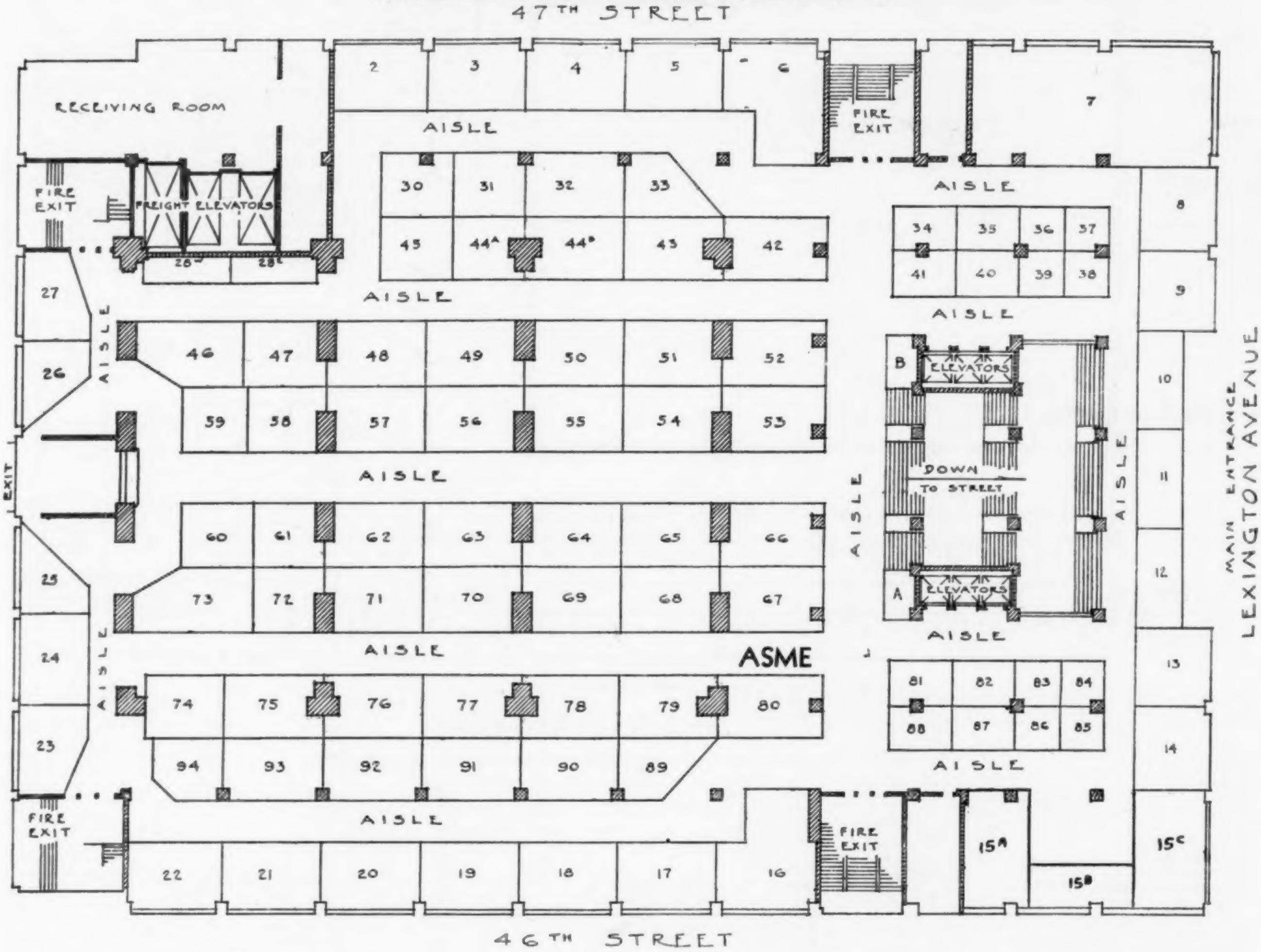
18th NATIONAL POWER SHOW

National Exposition of Power and Mechanical Engineering

Grand Central Palace, New York, N. Y., November 29 to December 4

Four Floors of Exhibits This Year — **Exhibitors List Begins on Page 94**

FIRST FLOOR—Booth Nos. 2 to 94



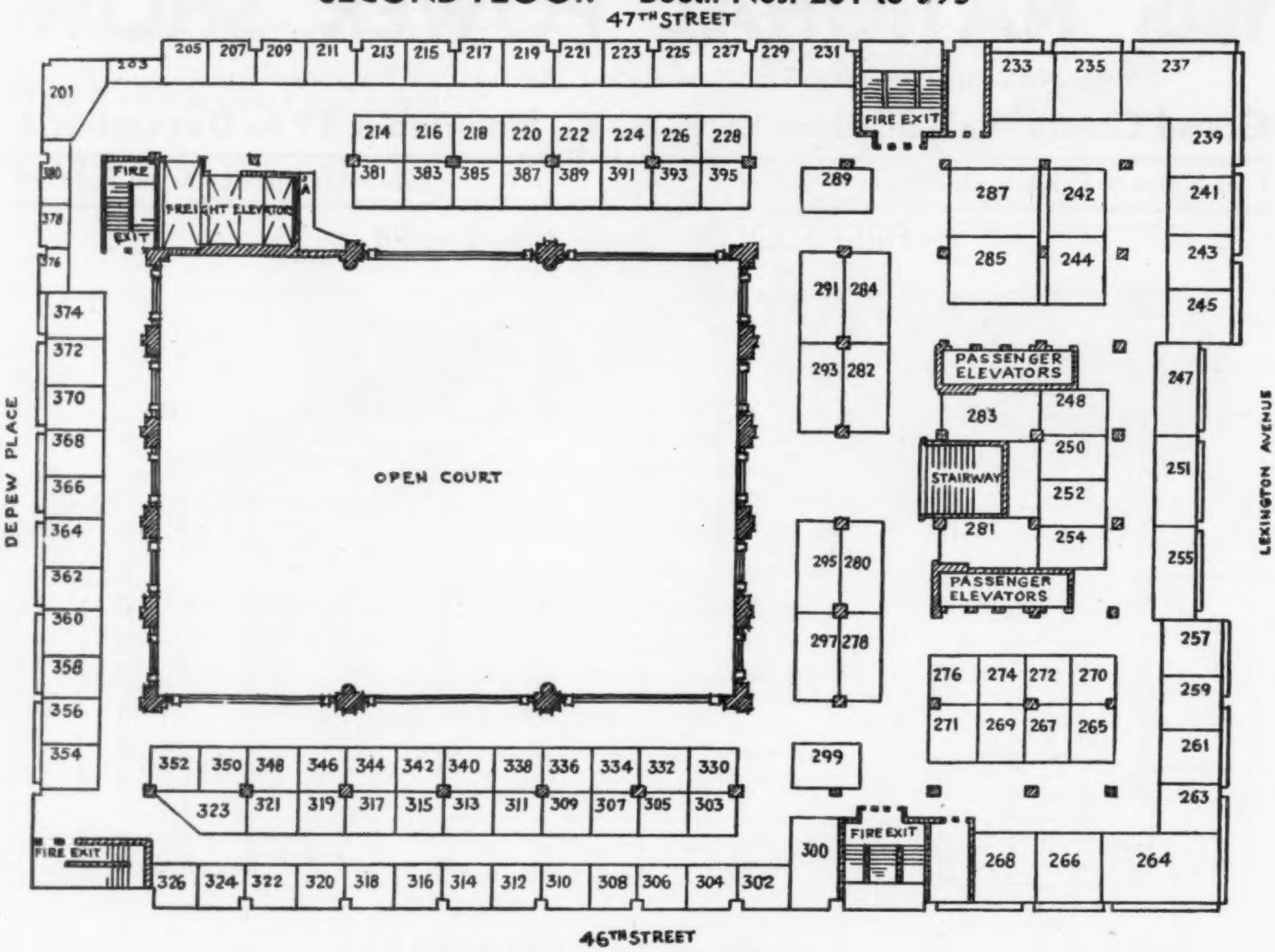
The 1948 National Power Show will be at its traditional location in Grand Central Palace with all of the available space taken on four floors by nearly 400 exhibitors showing the latest equipment used throughout the entire mechanical engineering field. In a wide range of displays the Show covers Power and Heat Production, The Means of Distribution and Control of Power and Heat, Auxiliaries, Instruments, The Mechanical Transmission of Power, Materials Handling, Machines and Machine Tools, and Engineering Materials. All of the exhibits reveal innovations and improvements introduced since the last Show in 1946.

Included among the many new exhibits will be a comprehensive display by one of the world's largest producers of refractories, a new stoker shown for the first time, a well-known steam engine, and additional exhibits of self-contained burner-boiler units. A scale model of the new Sunbury Generating Station of Pennsylvania Power & Light Company will be on display. This station is the largest anthracite burning plant in the world. New economies will be reflected in the long list of specialties, piping and valves, automatic recorders and controls, and instruments for many purposes. Improved construction will be featured in pumps and compressors, fuel and materials handling equipment, variable transmissions and drives, as well as many other kinds of power and power plant machinery. Metal Working Production Machines and Machine Tools will be on display also.

The Exposition will be open from Monday, November 29th to Saturday, December 4th inclusive. Opens Monday at 2 P.M. and then daily from 11 A.M. to 10 P.M.; except Wednesday and Saturday closes 6 P.M. As in previous years, the Exposition is being held the same week as the 69th A.S.M.E. Annual Meeting (Hotel Pennsylvania); and a special invitation is extended to A.S.M.E. Members to attend. Tickets of admission can be had without charge at the Annual Meeting and Society Headquarters. A.S.M.E. Members are especially invited to visit the A.S.M.E. Booth (No. 80) near the front entrance where information regarding A.S.M.E. activities and publications will be available.

A.S.M.E. Guide To 18th NATIONAL POWER SHOW

SECOND FLOOR—Booth Nos. 201 to 395



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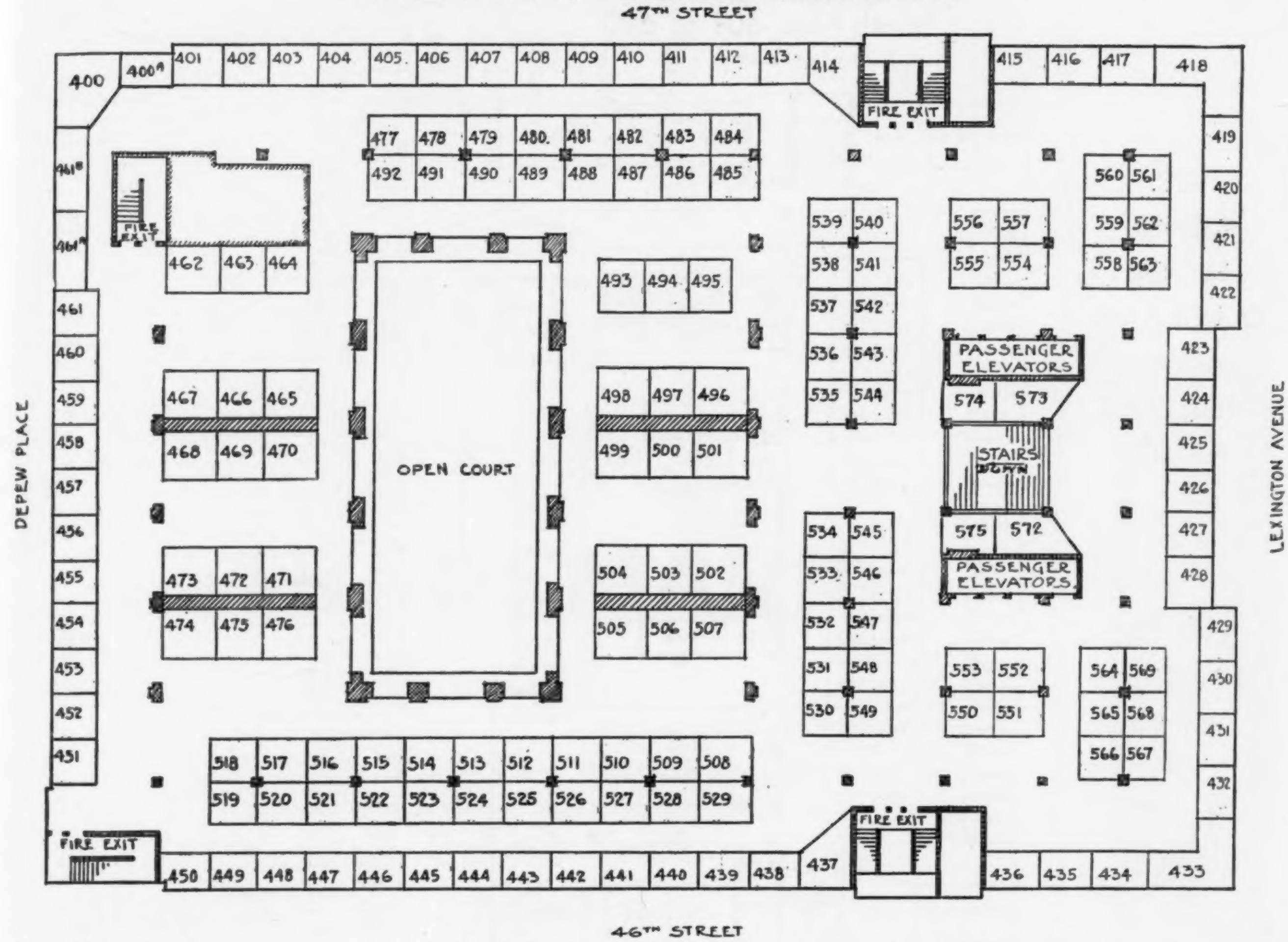

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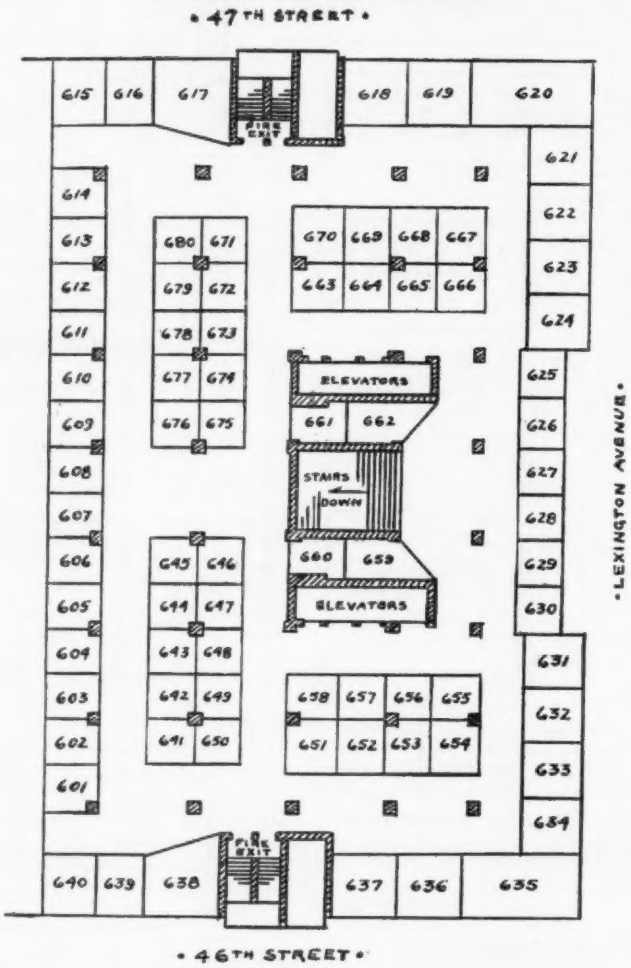

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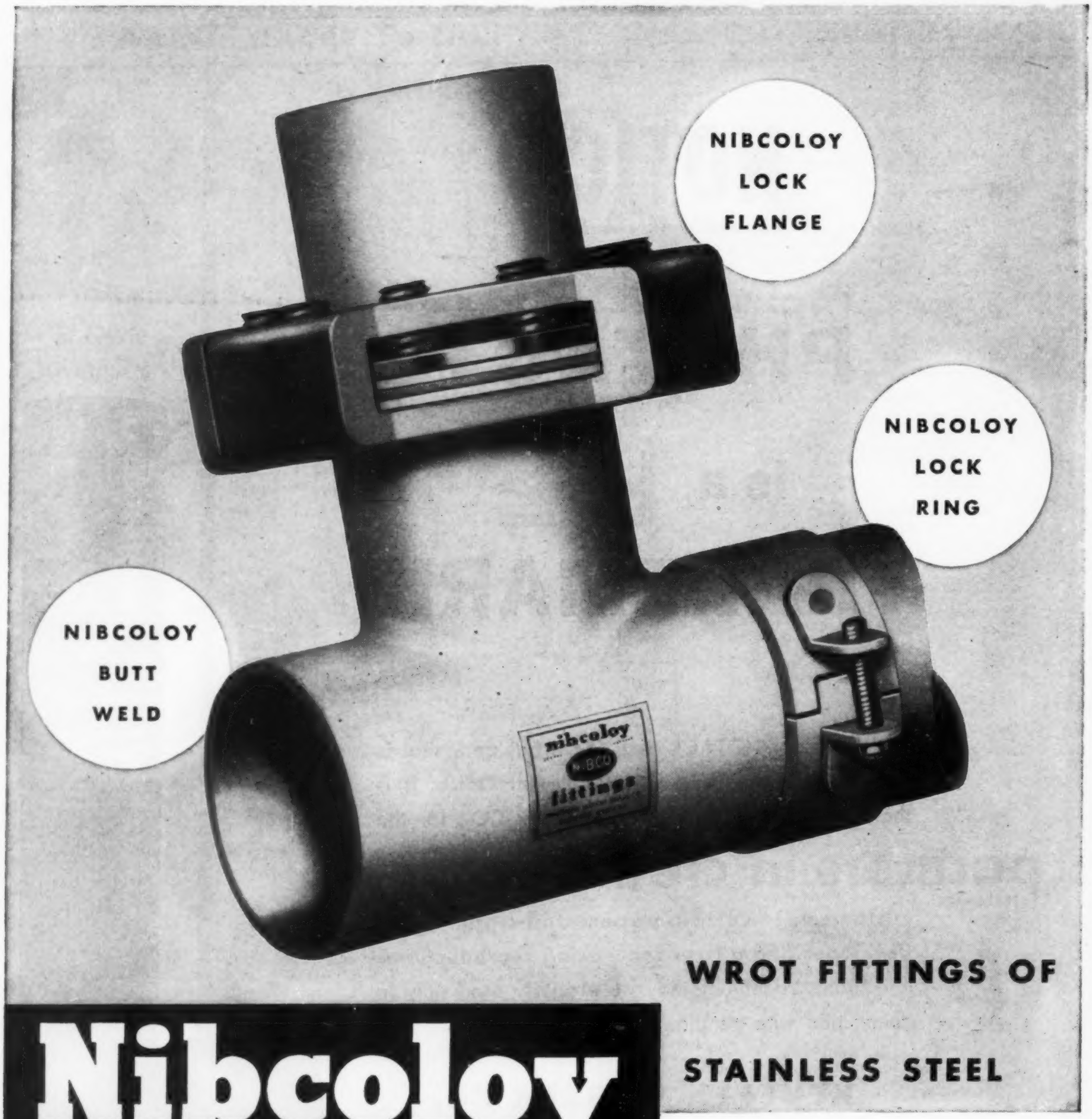

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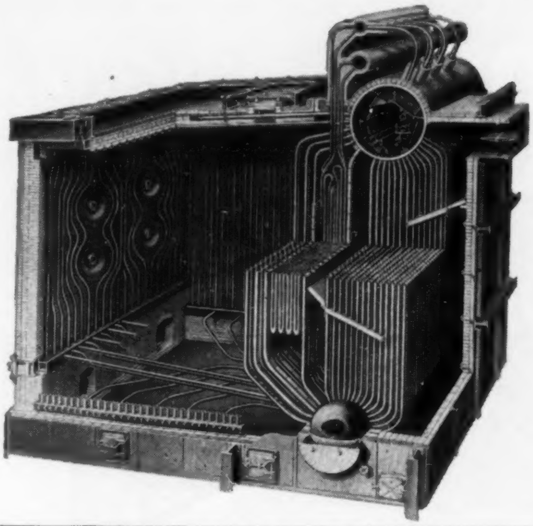
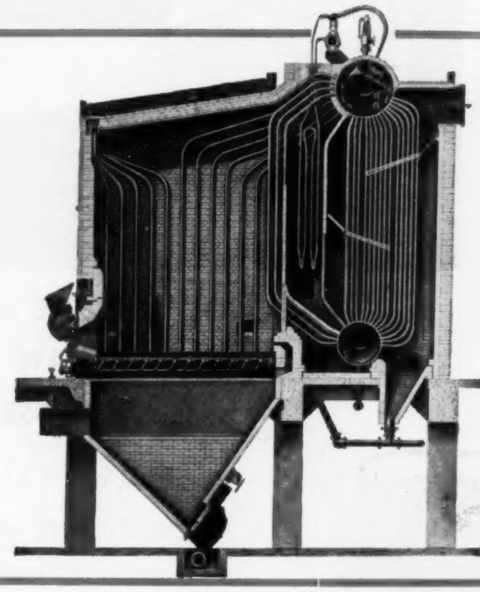


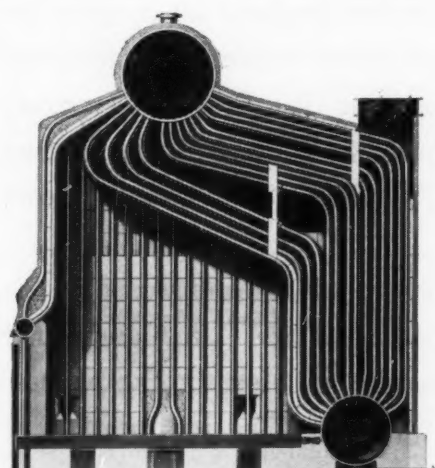
Type VU Steam Generator (for the higher capacity range)

This unit, the original VU design, may be fired by pulverized coal, oil or gas, or any combination of these fuels. Available for capacities up to 300,000, or more, lb of steam per hr, pressures up to 1000 psi and steam temperatures up to 900 F, or higher. Furnace bottom may be as shown or may be of hopper type. Economizer or air heater surface may be added.

Type VU Steam Generator (for the middle capacity range)

In this VU design, shown equipped with a C-E Spreader Stoker, the furnace proportions and arrangement of water wall surfaces may be adapted for firing by any type of mechanical stoker. Design is also adaptable for firing by oil or gas. Economizer or air heater surface may be added. Approximate capacity range 25,000 to 100,000, or more, lb per hr.





C-E Package Boiler (for the lower capacity range)

This member of the VU family is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 15,000 to 50,000 lb per hr. Firing may be by spreader stoker, single-retort underfeed stoker, oil or gas burners. Any of these methods may be substituted for any other, should fuel market conditions make this desirable.

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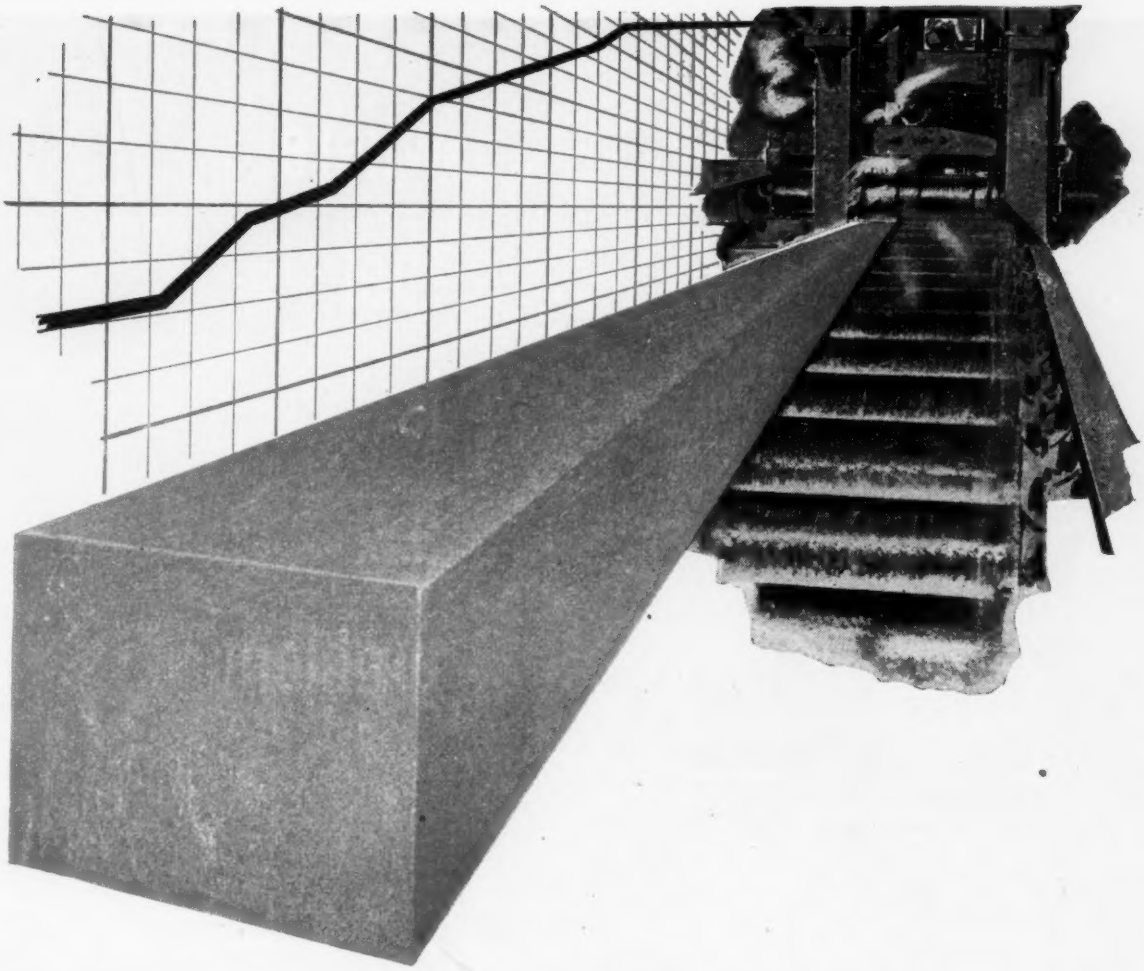

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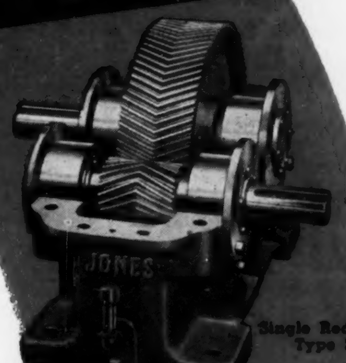
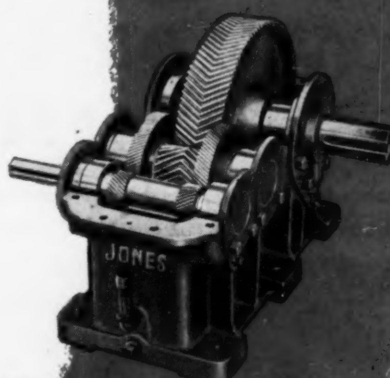
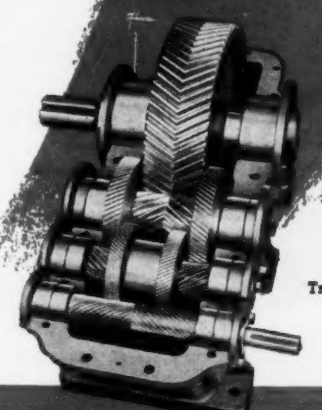


Single Reduction
Type SH



Double Reduction
Type DH



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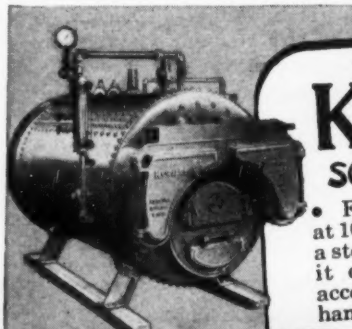

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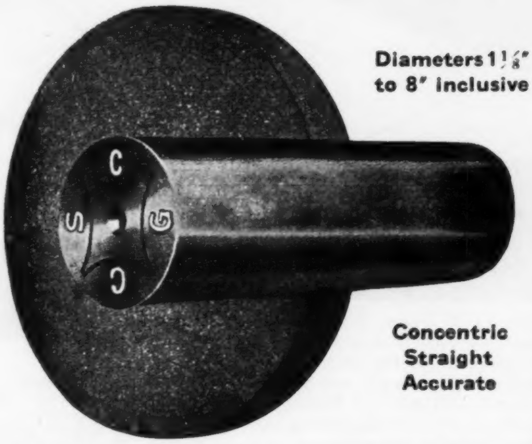

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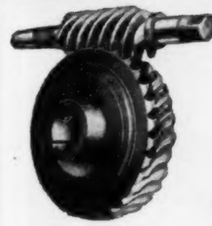

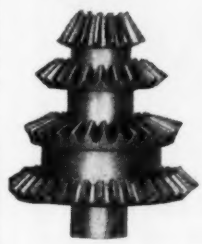

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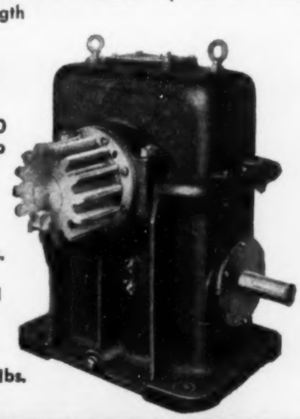

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October, 1948 — CARD INDEX — Vol. 70, No. 10

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KEY RESEARCH PERSONNEL

who can organize and conduct programs in the fields of

ENGINEERING

PHYSICS CHEMISTRY

Applicants with both research and development experience should write to

MIDWEST RESEARCH INSTITUTE
4049 Pennsylvania
Kansas City 2, Missouri

CHIEF ENGINEER

We are seeking an experienced Chief Engineer for our Midwestern construction machinery plant. Must have supervisory product development background in construction machinery. Should be an administrator and sales minded. Graduate engineer preferred. Age, 35–45. Excellent opportunity. Write about background in detail. Replies confidential.

Address CA-2778, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEER

With machine design experience and with a good theoretical background for stress analysis and in the field of mechanical vibrations. For design-development work of vibration testing equipment.

Sonntag Scientific Corp.
1 Seneca Place
Greenwich, Conn.

PRODUCT ENGINEER—with experience wanted as a permanent addition to the staff of an industrial Development Department located in Minnesota. Work involves product development including travel for consumer contacts. Program relates to products from wood. Submit detail education, experience, references, salary requirement, photograph. All replies considered confidential and will be acknowledged. Address CA-2742, care of "Mechanical Engineering."

RESEARCH ENGINEER—wanted to carry out fundamental research and development work pertaining to liquid rocket combustion chambers. An aptitude for experimental work on combustion and radiation is desired as well as a comprehensive knowledge of heat transfer, thermodynamics, and fluid mechanics. Development of instruments for measuring temperature, radiation factors, gas composition, etc., will be required. M.S. degree or equivalent is required in Physics, Physical Chemistry or Engineering. Write: Personnel Administrator, Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena 2, California, giving biographical data including education, experience, salary, and professional references.

STRESS ANALYSTS—Graduate in mechanical engineering or physics with five to ten years' experience in theoretical or experimental stress analysis, preferably on pressure vessels and heat exchange equipment. Knowledge of thermal stresses desirable. Excellent opportunity for qualified man in new Research and Development Department Laboratory. Write, giving resumé of education and experience. The Babcock & Wilcox Company, Research and Development Department, Alliance, Ohio.

RESEARCH ENGINEERS—with degree in Mechanical Engineering or Physics and five to ten years' experience in research or development work. For applied research on the flow of water, steam and air; metals under simulated service conditions; heat transfer; experimental stress analysis; all as applied to steam boilers and related equipment. Unusual opportunity for men in new research and development laboratory. The Babcock & Wilcox Co., Research and Development Department, Alliance, Ohio.

SALES ENGINEER—for automatic fees for punch presses. M.E. Graduate preferred. Previous experience with presses or dies would be helpful. Apply in writing giving experience, schooling, age, availability and salary desired. Littell Machine Co., 4127 Ravenswood Avenue, Chicago 13, Illinois.

RESEARCH DESIGNER—for the design of experimental apparatus. Each apparatus is designed individually to provide the conditions desired for the specific problem. These problems deal with applied research on heat transfer; metals under simulated service conditions; flow of water, steam, and air, experimental stress analysis. Degree in engineering or physics with about five years' experience in research or development is desirable. Address CA-2767, care of "Mechanical Engineering."

ENGINEER—for design and installation of steam and electrical equipment in new plant of expanding industry. After construction, man selected will have possible opportunity as plant engineer. Complete information required in first letter. All details confidential. Address CA-2768, care of "Mechanical Engineering."

ENGINEERS—Expanding Southern industry has openings for Mechanical Engineers for machine design, mechanical and process development work. Please give in first letter full details of education, age, experience, qualifications, references, availability and salary desired. Address CA-2769, care of "Mechanical Engineering."

PLANT ENGINEER WANTED—Mechanical or Electrical Engineer with plant experience needed. Man with some experience in handling production problems and designing production equipment preferred. Good opportunity for the right man. Location, small town Western New York. Address CA-2770 care of "Mechanical Engineering."

ASSISTANT PROFESSORS and INSTRUCTORS in Mechanical Engineering for general mechanical courses, industrial engineering and machine design. Salary: $3500 to $4500 for 11 months. Write: Dean of Engineering, Fenn College, Cleveland 15, Ohio.

COLLEGE INSTRUCTOR—desired to teach mechanical laboratory, heat power or machine design. Approximately $3000 for eleven months. Can work for Masters Degree. Write Head Mechanical Engineering Department, Montana State College, Bozeman, Montana.

ENGINEERS—large college offers $3000, approximately half time teaching-studying. All ranks university positions, experienced $4500–$6500 nine months. Give phone, photo, qualifications. Cline Teachers Agency, East Lansing, Mich.

CENTRIFUGAL PUMP DESIGNER—Experienced in the design of both single suction and double suction and non-clogging type pumps. Location: Midwest. First letter should give all details of educational background, previous employment, personal history and salary requirements. Address CA-2785, care of "Mechanical Engineering."

ENGINEER—graduate, electrical or mechanical, with experience in both, between 30 and 40 years of age capable of meeting people, working up estimates and propositions, designing, detailing if necessary, and following up in shop—by well established manufacturer of medium and heavy machinery for plywood and similar industries, and marine deck machinery. Location, New England, some travel necessary. Give experience in detail with past salaries and compensation expected. If possible include recent photograph. Address CA-2786, care of "Mechanical Engineering."

Inquiries invited from Mechanical Engineers for positions as DEVELOPMENT ENGINEERS with the American Optical Company, Scientific Instrument Division, Buffalo 15, New York. Must have ME degree or equivalent, and several years of experience in design and production of precision instruments or small machinery. Write to the Employment Office of the above Company giving full details of education and experience.

SEVERAL ENGINEERING GRADUATES—under 35, by large industrial fire prevention organization maintained by leading insurance group. Permanent position. Periodic inspections and special consulting service for leading industrial plants. Thorough training. Address CA-2791, care of "Mechanical Engineering."

MAKE USE OF THE OPPORTUNITIES SECTION

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

POSITIONS WANTED

PLANT MANAGER—Age 37. Licensed Professional Engineer, Cornell University. 13 years' manufacturing plant and engineering experience. Served apprenticeship in machine, foundry, assembly and erection shops, and engineering and sales department. Plant and process planning and layout, job specification and plant administration. Military experience charge of 3 development Laboratories' shops and plants. Present Director of Testing and Development Laboratory. Desire plant in N. J. or N. Y. C. Minimum salary $10,000 year. Address CA-2771, care of "Mechanical Engineering."

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POSITIONS WANTED

Continued from Page 121

MECHANICAL ENGINEER, BSME, some graduate work, 25 years old, single, 4 years' experience in development of the gas-turbine and other allied fields of research. Can do design, testing, and the writing of technical reports. Desires development and research work on gas-turbines or internal combustion engines, preferably with a small progressive industrial corporation, anywhere in the U. S. Address CA-2775, care of "Mechanical Engineering."

REGISTERED PROFESSIONAL ENGINEER—BSME, age 36. Fifteen years' activity in the design, construction, operation and maintenance of industrial and commercial properties and power and chemical plants. An aggressive indefatigable worker acquainted with all phases of the construction industry. Desires responsible position with industry or consulting firm with opportunity for advancement. Excellent personnel record and references. Address CA-2776, care of "Mechanical Engineering."

ACCURATE AND FAST MACHINE DESIGNER—plant layout, piping designer; good mathematician and stress analyst. Believes in starting with correct fundamentals. Graduate Mechanical Engineer, Navy Lieutenant inactive duty. Address CA-2777, care of "Mechanical Engineering."

MECHANICAL ENGINEER—B.M.E., registered Professional Engineer, age 32, now employed. Ten years' diversified experience. Desires responsible position with a future in the power plant design field. Must be located in or around New York City. Address CA-2784, care of "Mechanical Engineering."

ENGINEER—B.S.M.E., Age 30, Married. Four years' business and sales experience. Also development engineering and shop experience. Desires change to process industry which offers opportunity to advance to plant engineer. Will also consider a sales position. Address CA-2789, care of "Mechanical Engineering."

MECHANICAL ENGINEER—B.S.; M.S., Industrial. Recent graduate available for interview. Thirty-three years' old with general industrial experience. Capable of fast development into a position of staff responsibility. Address CA-2793, care of "Mechanical Engineering."

REPRESENTATIVES AVAILABLE

SALES ENGINEER—with headquarters in Kansas City desires to represent reputable companies as manufacturer's agent. Graduate Engineer with 7 years' production and design and 10 years' sales experience. Address CA-2764, care of "Mechanical Engineering."

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SALARIED POSITIONS $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (38 years' recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby Inc., 115 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000—$25,000

This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

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ESTABLISHED NEW ENGLAND MANUFACTURER—wishes to undertake development of patented, scientific, or technical apparatus to sell at approximately $750.00 per unit with a potential market of around 1000 units per year. Now equipped for heavy machine work but with ample floor space for light manufacturing and assembly. Will consider employment of a man with basic idea under a profit-sharing arrangement or will consider outright purchase of an established and proven product or patent. Address CA-2787, care of "Mechanical Engineering."

Old established leader in specialty precision manufacturing field employing on average 1000 men, seeks new product to manufacture, and if necessary, sell through existing sales organization. New product must be of a mechanical nature and in the precision class. Contacts (in confidence) desired with financially responsible individuals or concerns. Address CA-2783, care of "Mechanical Engineering."

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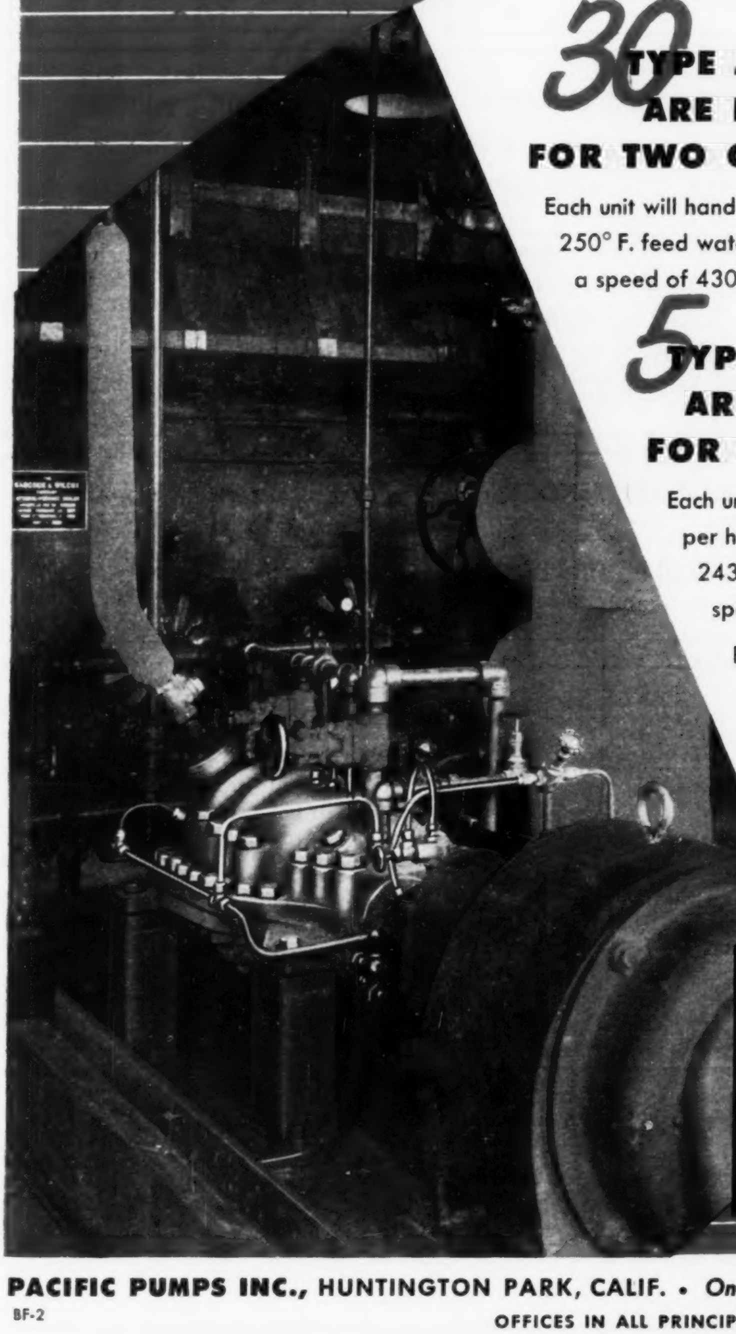

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WRITE FOR BULLETIN 82

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